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ON THE CAUSES OF HEATING AND CUTTING OR ABRADING IN BRASSES AND BEARINGS.

By Joshua Rose.

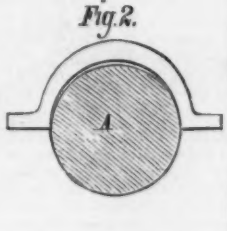
The friction of a journal against its bearing is, under a constant load, nearly the same, in proportion to the distance moved through, whatever the velocity of the movement may be; but since the friction generates its equivalent in heat, it is apparent that the greater the velocity, the greater the heat generation, because of the increased amount of the frictional duty performed in the same space of time. It becomes apparent, then, that the wearing surface of journals should increase with the velocity, though the load remains constant; the effect being that the increase of velocity reduces the pressure per inch of bearing area, and presents to the atmosphere a larger area wherefrom to abstract the heat generated.

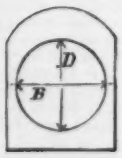
It is not our present purpose, however, to enter into the consideration of the proper proportions of journals to their loads or speeds more than to say that if the pressure on the longitudinal sectional area of a journal exceeds 800 pounds per square inch, even in a slow-running engine, heating and cutting will result; while in engines having a piston speed of over 220 feet per minute, the area referred to must be increased in about the ratio of 550 pounds per square inch for a piston speed of 440 feet per minute.

The causes of heating in journals of proper proportions, however, are as follows: 1st, improper fitting or bedding of the journals, and, 2d, softness of the journal-boxes or bearings. It is found in practice that, even under the most careful manipulation in clamping and boring boxes and bearings, their forms alter to an oval, of which the diameter across the joint is the smallest; thus, in Fig. 1. The bore of the eccentric strap, after being turned, would be narrower across A than across C, and the bore of the con-

Fig.1.

Fig.2.





necting-rod brasses would be narrower across B than across D; the result being that each half brass or strap, as the case may be, will bind upon the bearing, as shown in Fig. 2, A and B being the respective journals; and an enormous pressure would be required to force them on to the journals, so that they would bed upon the crown as they should do. To remedy this difficulty, the following methods are adopted. In small brasses—that is to say, those whose bore is four or less inches in diameter—the patterns for the two brasses are sometimes made in one piece, as shown in Fig. 3, being joined together by the narrow piece shown on each side at A. The practice then is to fit the brasses to their places, and to bore them out to a diameter larger than that of the journal; then, after boring, to cut them in half at A A, and let them sufficiently together; the result of the operation being that, even though the brasses close across the diameter, as shown in Fig. 1, they will fit down, upon the crown, and not bind, as shown in Fig. 2. The objection to this plan is that the brasses will close across the diameter, B, in Fig. 1, after they are bored (that is to say, when they are cut in halves), at A, in Fig. 3,

Fig.3

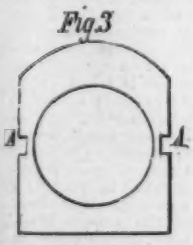
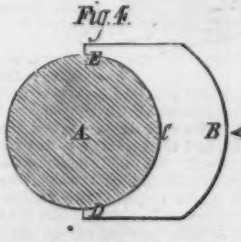


Fig.4.



to a degree *greater* than would be the case if they were cast separately; and though, through being bored larger in diameter than the bore of the journal, they may bed well upon the latter, they will have become loose in the strap or box unless care has been taken, in fitting them, to leave them a tighter fit in the strap or boxes than they are intended to be when finished (a precaution that should be taken in all brasses of eight inches and less in bore).

On connecting-rod and other brasses that are intended to key up tight together, the plan is sometimes adopted of boring them out a trifle too large for the journal, and then cutting away from the joint faces, where the two halves meet, sufficient metal to permit each half to bed upon the crown. This, however, is a tedious process, and the better plan is to place between those faces a piece of sheet-tin; or, if the bore of the work is greater than six inches diameter, two thicknesses of, say, double cross sheet-tin; and to cut off pieces of the same tin and place them beneath one end of the inside gauge, or one leg of the inside callipers, as the case may be; the same being set to the correct size of the journal, and care being taken to leave the bore a shade tight to the callipers or gauge, so as to leave a little to take out of the bore when fitting it, and thus obviate the necessity of having to file off the faces to let the two halves together while fitting them. It is obvious that, were it practicable to make the exact necessary amount of allowance the brasses would require, but little fitting or adjustment would be requisite; but it is found in practice that, no matter how true the work may be lined, fitted, and bored, boxes of every description require fitting to their places; and, furthermore, it is found that if a brass bears all round its half circle, it will grip the journal and heat, and, under heavy duty, seize or cut, the reason being made apparent in Fig. 4, A representing the section of a crank-pin, and B a brass, the power required to move, A being placed upon B in the direction of the arrow. The strain upon the metal at C will be then one of direct compression, whereas that at D and E will act as a wedge. It is also found that if a brass is very thin at E and D, the pressure at C tends to force those points in a direction to approach each other and bind upon the journal; while the brass, being thin and comparatively weak at E D, springs from the pressure; thus exerting a constant pressure upon the journal and causing it to heat. To obviate these tendencies, it is necessary to ease away the brasses or eccentric straps, as the case may be, at the sides, as shown in Fig. 5, at

Fig.5.

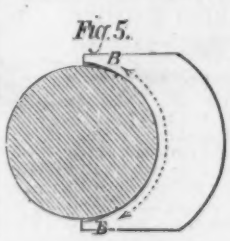
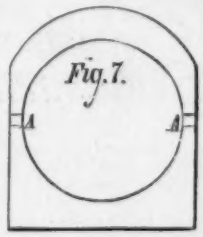
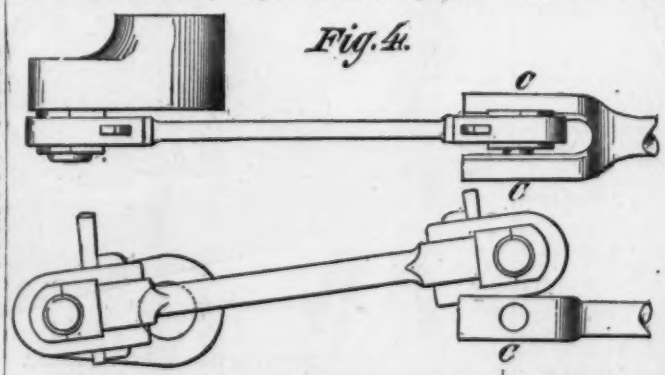


Fig.7.



B B, so that each half will only bed against the journal around the surface denoted by the dotted line. The first thing to be done, then, is to ease away the sides, B B, of the bore on each half brass, until the crown of the brass beds fairly upon the journal. Then, if the brasses are stationary, the shaft and brasses must be put together in their working places and properly adjusted, when the shaft should be revolved, so as to mark the high parts upon the surfaces of the brasses, these high parts being removed with a file and a half-round scraper. The work must be put together and again tested, the operation being continued until the marks show the boxes to bed evenly. If, however, the brasses are held in moving parts, such as levers or connecting-rods, the bearings must be fitted to *lead* true by connecting one end of the rod only, as shown in Fig. 6; and, after adjusting the brasses to a proper fit,

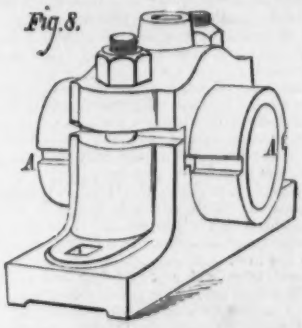
Fig.4.



lower the disconnected end, with its brasses in their places in the rod, down to the journal; and if the rod at the disconnected end is found to stand on one side of its proper position, it should be moved back and forth under a lateral pressure, placed by hand upon the rod end, and in the direction in which the rod end requires to go, the object of such pressure being to mark plainly the high parts of the journal. This operation, which is called fitting the rod or lever to *lead* true, is indispensable to good workmanship, and, under ordinary duty, to prevent heating; because if a small portion only of the surface of the brass beds to the journal, such comparatively small surface will receive the whole of the friction due to the load of the journal, and will in consequence heat and abrade, cutting a rough surface upon the journal, which must be removed before the journal can be expected to keep cool.

The brasses for fast-running journals should come brass and brass; that is, their faces should touch and lock together by the pressure due to the key or the bolts, as the case may be; so that when, in the fitting, the adjustment is so made as to permit of the key being driven tightly home, there is no danger of the pressure due to the key binding the brasses too tightly upon the journal, and thus causing it to heat. If the position of a box or brass renders it difficult to take it out from its place, and there is but little wear upon it the joint of the brasses may be left open to permit of adjustment without filing off the faces; but if it is at all convenient to take out the top brass even, the brasses should be made to lock each other by the interposition between their faces of two liners or fitting strips, as shown in Fig. 7, at A A, which strips may be taken out and filed thinner, when it becomes necessary to let the brasses together to take up the wear. To ascertain the thickness such liners require to be, a piece of lead wire may be placed between the brasses at each of the four corners, and the tightening up of the bolts or key will compress the wire to the requisite thickness. The liners, however, should be made a shade thicker than the wire compresses to, to relieve the journal from any undue pressure from the brasses. If the brasses have a comparatively large area upon the joint faces, and are made to come brass and brass, the faces may be cut partly away, as shown in Fig. 8, at A A,

Fig.8.

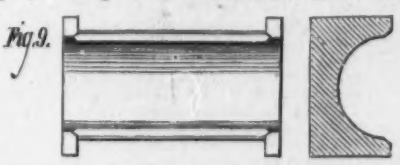


thus reducing the area, and rendering the filing or letting together a more easy and expeditious operation.

In letting such brasses together, the joint faces should be made true and square with the flange faces of the brass, so that locking the brasses together will not spring the latter out of true, and thus cause them to bind unduly upon the journal.

In addition to the oil-grooves in the crown of the brass, there should be cut in each half brass a groove, such as shown in Fig. 9, which groove should terminate close to the end-

Fig.9.



faces of the brasses, thus preventing the oil contained in them from rapidly working out of the journal.

If the above directions are carefully followed, and the journals themselves are true and line true, and proper lubrication is provided, there is no danger of the bearing getting heated, except it be that the metal of which the brasses or boxes are made is too soft. For heavy duty, a mixture, in the proportion of copper, 15, tin, 2, spelter, ½, will be found excellent, being as hard as is necessary, and not expensive to turn and fit.

MECHANICAL VENTILATION OF MINES.

The autumn meeting of the Institution of Mechanical Engineers was recently held in Manchester, at the Memorial Hall, Albert Square. In the absence of the President, the chair was occupied by Mr. J. Ramsbottom, one of the past presidents.

After the election of officers for the ensuing year, the secretary of the institution (Mr. W. P. Marshall) read a paper, by Mr. W. Daniel, of Leeds, on mechanical ventilators for mines, in which the author said that in a paper on mining machinery read before the institution sixteen years ago, by the late Mr. T. J. Taylor, the ventilation of mines by furnaces placed at the bottom of upcast shafts, as compared with the mechanical appliances then in use, was for valid reasons considered the best and safest method. But, notwithstanding its admitted simplicity, the rarefaction of the outgoing air by heat to produce the ventilating current had proved troublesome, expensive, and dangerous. Under these circumstances it was not surprising that, since the subject of mechanical ventilation was last brought before the institution, six years ago, the adoption of the greatly improved mechanical appliances then described for the ventilation of mines should have been so extensive, and that in this country there were at pre-

sent about 250 mechanical ventilators in actual use or in course of construction. In the matter of fuel consumption, the best existing appliances would be about on an equality with furnaces when the latter were employed at a depth of about 700 yards, and the less the depth the greater did the economy of the machine become; but it might certainly be asserted that the furnace ought never to be employed excepting in small mines, where the duration of working and physical conditions were such as not to justify the additional outlay required for a fan. Most, if not all, of the mechanical ventilators at present in use exhaust from the top of the upcast shaft in the case of pits, or at the end of the return air-course, where they were employed for day working. The author submitted a statement of the results of experiments on some of the different systems for the mechanical ventilation of mines, and in conclusion called attention to the fact that, in the majority of ventilators now working, low pressures, very little expansion, and consequently wasteful types of engines, were usually employed where, owing to the almost constant work, a more economical engine might be advantageously adopted.

Mr. Charles Cochrane (Stourbridge) read a paper on the "Ultimate Capacity of Blast Furnaces," in which he said that in the course of a long investigation into the effective working capacity of furnaces, he had been led to conclude that there was an unmistakable source of falling off in the working of blast-furnaces not securely cased in iron, which had hitherto been overlooked, and which in such furnaces was the source of increasing loss the longer a furnace had been in blast.

[The Pharmacist, Chicago.]

ALUM IN WYOMING TERRITORY.

Alum is a double sulphate of alumina and potash, containing 24 parts of water to 1 of sulphate of potash, and to 1 part of sulphate of alumina. There are also various other alum combinations with other sulphates, but in just exactly the same quantity as the above named. Those other sulphates are sulphate of ammonia, soda, iron, magnesia and manganese, and a hydrous sulphate of alumina, called feather alum, a very impure substance.

The potash alum is the variety more commonly in use; it occurs in clay slates, shales, and clays. Alum is formed by the decomposition of iron pyrites. It is cubical crystal, also in regular octahedrons; the cubical form derived from an octahedron. In the process of alum formation in nature, as the pyrites decompose, the sulphur and iron unite with oxygen, which is derived from the water present, and then becomes a compound of oxide of iron and sulphuric acid. The sulphuric acid readily unites with the clay and the sulphate of alumina is formed.

With the one part of magnesia or ammonia a good commercial alum can not be formed. To determine if the substance carries the sulphate of alumina instead of the other substances, heat to redness and wet the mass with nitrate of cobalt in solution; heat again, and if it assumes a blue color before fusion, the alumina is present.

If ammonia or soda replaces the alumina it does not change the crystallization. Soda alum is found in three or four places in France, South America and Wyoming. Ammonia alum is manufactured in France to a considerable extent, but is inferior to the first.

Alum is used largely for preserving and tanning skins; for coloring in cotton and other goods; for dyeing, whitening and hardening tallow or candles; for purifying liquors; in medicine and glazing paper. It is also used extensively in the adulteration of bread, giving it a white color. Alum applied to wood or paper that is porous, renders it utterly incombustible, and free from the attack of worms.

The first mention that we learn was made of alum was by Pliny, but this substance was very probably the green vitriol of the present time. The origin of alum is very much obscured. We can discover that it was in use in the fifteenth century, and at a later period manufactured at Rocca and Odessa, in Syria. From the former place the rock alum of commerce took its name. In the fifteenth and sixteenth centuries, alum was made in Italy, in Constantinople and in Smyrna. In Italy the Pope protected it against importation from the other countries, and made large amounts from its manufacture and sale. About this time it was introduced into Germany, and extensively made in that country.

While Queen Elizabeth was on the British throne, Thomas Chaloar commenced its manufacture at Whitby. The Pope did all he could to break up this manufactory, but he did not succeed, as the same works are in successful operation at this time. Near Glasgow, in Scotland, there are two extensive industries producing alum.

The alum at most all the European works is produced from an argillaceous slate which is largely composed of alumina. This form of alum is of sedimentary origin, and forms much the greater portion of the substance from which alum is produced. But there are quite extensive deposits of alum stone, a combination of alumina, potash, sulphuric acid, and water, in a crystalline condition. We are told that this rock-alum stone is only found in volcanic regions, but this is an error. In several localities in the western territories there is alum stone in the tertiary and cretaceous formations. The sediment from which these strata were piled up may in part be the result of decomposed scoria and volcanic matter; but conditions now have no volcanic presentations. Wherever alum stone is found, it may be quarried like any other rock, and at no great expense.

Alum is made from alum stone, by placing the rock in large kilns made of sandstone, or in heaps on the ground, or in pits in the ground, or in deep trenches. When the rock is in position in any of these places, it must be watered regularly every day by sprinkling; if in pits or kilns, a very slow fire adds more rapidly to decompose the stone. When all is reduced to fine powder, the second stage of operation commences by boiling the powder in water in lead pots by the use of steam. Evaporation quickly goes on, the earthy matter settles to the bottom; the liquid is drawn off and crystallizes into the article known as Roman alum, with a purple or reddish hue, from the presence of a small quantity of sesquioxide of iron.

Alum slate is much more easily treated and gives more of the article to commerce. Alum slate is found in Canada, Pennsylvania, New-York, Connecticut, Massachusetts, California, New-Mexico, and Wyoming. This alum, or argillaceous slate, contains iron pyrites in large quantity. In treatment, a portion of the sulphur sublimes, the remainder quickly absorbs oxygen, and readily passes into sulphuric acid. Now a combination with the iron in the pyrites is effected; also a portion with the alumina of the argillaceous slate, and a protosulphate of iron is formed. This is simply green copperas. The other component part is the sulphate of alumina, which is the base of alum; the addition of potash consolidates, and cubic alum is produced.

To detect these slates, look for grayish efflorescence upon the surface where exposed. Most of these slates will be found to crumble easily and have an acid taste.

The calcining of these slates is by no means a difficult matter. Their treatment is very simple, and is not materially different from that of the alum-stone. Where these slates are treated in various countries, the processes are not dissimilar, but are much more extensive in some than others. In the Whitby works, in Scotland, piles of the slate containing many thousand tons are in process of calcination at a time. After the first heat is secured to start the process, no more fuel is required, as the chemical condition present furnishes all that is needed. In these works, when the calcined slates are fully decomposed, and the sulphur has become sulphuric acid, and combined with the oxide of iron and alumina, they are placed in large vats and lixiviated with pure water. Then this liquid is boiled and the earthy matter thrown down as before stated. The solution now had by evaporation is as before, basic alum and copperas. The iron salt is now easily got rid of by throwing the liquid in receivers and letting crystallization do its work of separation.

In the United States there are a number of extensive alum works. They are in Salem, Mass., and at Philadelphia. Alum is manufactured here by treating the clay directly with sulphuric acid, and adding the potash.

The deposits in Wyoming are at Point of Rocks, on the U. P. Railroad, near Evanston, Percy; on the breakwater; four localities along Bitter Creek and near Ogden in Utah. The most extensive deposit determined exists at Point of Rocks, and in that immediate locality. The argillaceous slate here occurs immediately along the line where the lower tertiary coal measures come down to the upper cretaceous. Here are slates and clays deposited to a depth of 13 feet, and as rich in alum-producing qualities as are found in the world. A great part of this bed or strata is already in a transition state, and only requires lixiviation and crystallization. Nature has fully carried forward the calcining process, and there are thousands of tons ready for treatment. The process for calcining can be very cheaply carried on here; coal but a few feet away and plenty of water from white sulphur springs can be easily conducted to the pits, ovens, or heaps of slate, also for the lixiviation processes. Right here are some of the most extensive sulphur deposits in the country; and in connection with alum works, the manufacture of sulphuric acid could be cheaply and largely carried on.

The decomposed slates that are alum-producing underlie many thousands of acres, and are exposed in eleven places in this region; none more than three miles from the line of the Union Pacific Railroad.

Alum can be manufactured here at a less price than elsewhere; the supplies are present in such abundance, superior quality and combination, that there is no question admissible of the above statement. With a steady production of alum, sulphur and sulphuric acid on the line of the road, the management of the Union Pacific Railroad Company can afford it liberality in transportion that will completely foster these industries and place their products in the markets of the world at a very liberal profit.

IMPROVED REED-MAKING MACHINE.

The reed-making machine, illustrated below, is one constructed by Mr. Thomas Barraclough, of Manchester. Before flattened wire was introduced by the celebrated John Kay, the inventor of the fly-shuttle, thin slips of reed were used to form the dents or teeth of the reed or comb—hence the name reed—the adaptation of machinery for binding the short pieces of reed together to form the comb, or stay, would prove a doubtful task. But when long lengths of flattened wire were substituted the difficulty no longer existed, for the wire could be drawn off the ring or coil, and after being inserted in the guide it could be drawn, cut, and inserted with great rapidity.

The comb or reed used by weavers is composed of thin pieces of steel wire about four inches long by ¼ in. wide. They differ, says *Engineering*, from an ordinary comb by having both ends of the teeth or dents bound together and held firm in order to withstand the force required for beating the weft threads together. They are made in lengths according to the width of the cloth to be woven, and vary in fineness or number of dents corresponding to the material to be woven. The number of dents varies say from 10 or 20 to 120 or 140 per inch, and great regularity is requisite in the gauge or distance apart of the dents, for any defect would be easily observed, and injure the evenness of the cloth.

The action of the machine illustrated is exceedingly simple. Four semicircular wood rods, to form the border or

IMPROVED REED-MAKING MACHINE.

frame of the reed, or rather two rods cut down the centre, are fixed upon a sliding frame in the machine, as shown at *d d*, and held firmly, about 3 inches apart, by screws as shown. The flat wire being wound off a ring or coil, is passed between the guide-rollers *a a*, and inserted between the two pairs of rods *d d*, when it is cut off to the required length. A waxed thread is then wound firmly round each of the bars *d d*, and pushed up against the dent or flat wire tooth, which was last inserted, and not only binds the dents in position, but the gauge can be very correctly arranged by regulating the thickness of the wire and waxed thread to correspond with the feed motion of the machine.

The thread is supplied from two bobbins, one for each of the rods at *d d*, as shown at *e e*, and, as the rod slides through the boxes on which the bobbins are fixed, the boxes make a revolution and carry with them the binding thread. A finger then presses the dents together as before stated, according to the desired gauge, or distance of the dents apart, and the operation proceeds. Of course it is necessary that each of these movements should be properly timed, for it is evident that they must follow each other in a somewhat intermittent manner. This, however, is well carried out, and reed-making at the present time forms a curious contrast to the process as carried out less than a century ago, when the manufacture was altogether performed by hand.

At each end of the comb a few stronger wires are inserted to give additional strength, and the waxed threads which completely cover the rods, being so close together, have paper pasted over to keep them from injuring the warp.

[Chemical News—Comptes Rendus.]

CHEMISTRY.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Specific Gravity of Pure Platinum and Iridium and their Alloys.—MM. H. Sainte-Claire Deville and H. Debray.—Pure platinum was found to have the specific gravity 21.504. Iridium gave 22.421. An alloy of 90 platinum with 10 iridium 21.615, showing a contraction of 0.0012. Another alloy of 85 platinum and 15 iridium was found 21.618, the contraction being 0.0003. An alloy of 66.67 platinum and 33.3 iridium gave 21.874, the contraction amounting to 0.0034. A brittle alloy of 5 platinum with 95 iridium — 22.384, and the contraction was 0.0006. The specific gravities of platinum and iridium are higher than have been hitherto found, and the specific gravities of the alloys increase in a very regular proportion, which affords a presumption in favor of their purity.

Certain Compounds of Titanium.—MM. C. Friedel and J. Guerin.—In a certain number of its compounds, titanium is unquestionably analogous with silicium. The researches of M. Marignac on the fluo-salts of silicium, titanium, tin, and zirconium, have brought certain of these analogies to light. Other analogies result from the comparison of the chlorides, bromides, and iodides of silicium and titanium, and between the ethereal compounds of titanium and the ethyl-titanic trichlorhydrine of Friedel and Crafts, and the titanic ether of Demarcay. Along with these resemblances we find also differences. We know of no silicates resembling the known titanates. Hypersthen, the mineral which most nearly approaches in its composition to the numerous and varied titanates of iron, offers no analogy to them in form and aspect. Of the three forms of crystalline titanic acid, not one approaches that of silica. The authors, therefore, deemed it important to undertake a re-examination of certain compounds of titanium, and have studied the dichloride and the dititanic hexa-chloride.

Solution of Platinum in Sulphuric Acid during the Industrial Process of Concentration.—M. Scheurer-Kestner.—The author concludes from his experiments that the loss of weight in platinum stills is not due to a simple mechanical action of the boiling acid. When the acid is free from nitrous compounds it dissolves about 1 grm. of platinum for 1000 kilos. of acid concentrated to 94.100. If the concentration is carried to 98.100, 6 to 7 grms. are dissolved, and 9 if the acid is prepared at 99.5 per cent. If nitrous compounds are present the amount of metal dissolved is in much larger proportion. Platinum alloyed with iridium is much less attacked, an advantage, however, which is, to a great extent, compensated by the brittleness of the alloy.

New Alkaloid, Ergotinin, found in the Ergot of Rye.—M. Ch. Tanret.—This compound is a fixed solid, exists only in very small amount, and is very readily affected by the air, which renders its extraction difficult. Like all the alkaloids, it has a decided alkaline reaction, and saturates acids. It yields precipitates with the double iodides of mercury and potassium, with the iodouretted iodide of potassium, phosphomolybdic acid, tannin, chloride of gold, chloride of platinum, and bromine water. Its most striking reaction is the color which it gives with moderately concentrated sulphuric acid—a yellowish red, which becomes an intense violet-blue. If it has been exposed to the air for some minutes it loses its distinctness, and finally is no longer produced. Its saline solutions, on exposure to the air, quickly become rose colored, and then red. If the extractive liquor is distilled with a concentrated solution of soda or potassa, mere traces of the alkaloid are obtained, but, instead, a large amount of methylamin—doubtless a product of its decomposition. In another experiment, where the liquid had been submitted to prolonged evaporation in the air, nothing but ammonia was obtained, all the alkaloid having disappeared. The great instability of this alkaloid may explain the rapid alteration of the powder of ergotized rye.

THE PRESENCE OF DEXTRINE IN THE URINE.

It is stated that under the influence of the alkaline waters (Vichy, Vals, Carlsbad) the sugar entirely disappears from the urine of diabetic patients, but that the liquid still continues to act feebly as a reducing agent in Fehling's test. According to E. Reichardt, of Jena, this is owing to the presence of a small quantity of dextrine. His method of analysis is as follows: The urine is evaporated over a sand-bath to a syrupy consistence; the residue is treated with alcohol, and caustic potash as in testing for sugar; a deposit is formed, from which the supernatant liquid is easily separated. The deposit is washed several times with absolute alcohol, and then treated with dilute acetic acid, by which it is dissolved. The addition of absolute alcohol again reprecipitates the dextrine; the alkaline acetate and the sugar (of which slight traces exist) remain in solution. After being well washed with alcohol, and then dried, the precipitate becomes a white powder of an insipid taste, and soluble in water; its aqueous solution reacts very slowly to Trommer's test, very dilute sulphuric acid transforms it into glucose, which reacts to Trommer's test immediately. On contact with iodine the powder becomes of a brownish-red color. The elementary analysis gives the C^{24} H^{20} O^{20} of dextrine or glycogene. Nothing is said with regard to its action on polarized light.—*Journal de Pharmacie et de Chimie—Journal de Médecine.*

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MACCORD, Stevens Institute.

(Continued from page 7.)

OUR illustrations of the triangles given on page 4 were made in full size, in order that they might serve as patterns for beginners who desired to make their own instruments. Supposing that our students are now in possession thereof, it will not be necessary, in future instructions, to make our examples so large, and we shall, therefore, now reduce the dimensions of our drawings and thus economize space.

The next thing is to draw, through a given point, a straight line parallel to one already drawn. The triangles are the best of parallel rulers, far superior in convenience, range, and accuracy to any of the expensive instruments sold under that name; for as the triangle does not change its shape, it is clear that if one side of it be placed against a fixed ruler, and moved along in contact with it, either of the other sides will remain always parallel to itself.

In Fig. 9, let L M be the line, and P the point. The first thing is to place one of the triangles, as B, so that its upper edge shall be parallel to L M. The novice would very likely and very naturally attempt to make the edge *coincide with* the line; but this is extremely difficult, for if the line be very fine it is apt to be quite hidden, and if it be not, its thickness renders it difficult to avoid putting the edge of the triangle farther over the edge of the broad line at one part than at another. It is, then, better to place the triangle *near* the lower side of the line, as shown, precisely as if the object were to draw the same line over again—the eye will be found able very accurately to judge of the uniformity of the narrow space between the edge of the ruler and the line. (This calls attention to the superiority of black-edged triangles to those which are white.) Having adjusted B, it is held firmly, and the other triangle, A, is placed against one of its sides, as shown, care being taken that nothing interposes between the sides in contact; then holding A firmly on the paper, slide B until a line drawn by its upper edge will pass through P. The triangle A may be held by pressing upon it with the thumb, the first and the little fingers of the left hand; the other two fingers of the same hand will suffice to hold B always against the edge of A, to press it upon the paper while drawing the line, and at the same time will have considerable freedom of movement, so that a series of parallels through different points near each other may be drawn with rapidity and certainty; the right hand not being at all concerned with the operation of moving the sliding triangle, is always ready to draw the line when the adjustment is made, and much time is saved.

Dexterity in this manipulation is of great importance, and the best method to acquire it is to practice the operation here described, over and again, until it is done without thinking about how it is done, just as one forms the letters in writing without stopping to call their shapes to mind.

Next, to draw through a given point a line at right angles to a given line. In Fig. 10, let L M be the line, P the point.

The triangle B is first adjusted with regard to the line as before, A placed in contact with it as shown, and held fast. (The line to be drawn being vertical in this instance, the position of A is so chosen that it may be drawn by the left-hand edge of B when placed in position.) A being now held fast, the position of B is changed to that shown in Fig. 10; the other side bounding the right angle being now in contact with the same edge of A, *any* line drawn by that edge of B which was at first parallel to L M will be perpendicular to that line—it is then only necessary to slide B along A until the new line will pass through P.

Evidently, both these operations of drawing the parallel and the perpendicular to the first line, might be performed by using the other triangle as the ruler; but it will be found that the second one can usually be effected most conveniently by using the one of 45°, as we have shown in the cut. And we repeat, that the beginner need not fear that he will do himself any harm by practicing these simple operations until they become even tiresome, if he will only take pains to perform them carefully. He should not rest contented until he can perform them with perfect certainty and accuracy; and in order to make sure that he has done so, it is well in each case to replace the sliding or movable triangle in the first position of adjustment as to parallelism with the given line, to make it absolutely certain that the fixed triangle has not slipped on the paper. In order to acquire facility in using the triangles under all conditions and circumstances, the line to which the parallel or perpendicular is to be drawn should be placed in various positions—not always horizontal or vertical, as we have shown it in the figures, but inclined to right or left at different angles, until the handling of the instruments become easy in all cases. And, for the purpose of gaining a control over the marker, so that the pressure shall be kept uniform, which is essential to the drawing of a smooth, even line, it will be found good practice to draw lines with a common writing-pen, using for this a thick ruler, as the thin triangles, allowing the inky nib of the pen to touch the edges, would be sure to cause the line to blot.

LESSON II.

By proper use of the triangles, in the manner explained in the previous lesson, a great number of interesting and useful exercises may be executed, without any other instrument except a strip of paper, on the edge of which marks may be made for the purpose of measuring or setting off distances. We do not pretend that they could not be done with greater facility by other means, or that compasses, dividers, and scales are unnecessary, if a great deal is to be done in the way of mechanical drawing. But, supposing that they are not at hand, we wish to show that the lack of them need not debar the learner from practice that by a little ingenuity may be made entertaining as well as useful; which we hope to do, though without beginning to exhaust the almost endless variety of combinations which may be executed by the aid of the simple apparatus already mentioned: the ever-changing figures in the kaleidoscope and the exquisite beauties of the snow-flakes require nothing more for the reproduction of their forms, which might serve as an elegant and profitable recreation for the gentler sex.

As just stated, a slip of paper answers a good purpose to measure with; nor is it to be considered as a mere makeshift, for in the copying, particularly, of even the most elaborate drawings, this ready device is very frequently employed to great advantage for transferring measurements. Moreover, instructions will be given in due time, by the aid of which quite accurate scales of equal parts may be made by the use of the triangles alone, which will answer as good a purpose as any for the construction of mechanical drawings in correct proportion. The writer has frequently used them for complicated work, which required to be reduced in such a proportion that the usual scales would not answer.

For our present purpose, however, it is enough to say, that all that is necessary is to cut a slip of paper with a smooth, even edge—the margin of a sheet of foolscap is the best—say an inch wide and five or six inches long. In marking this, it should be laid on the drawing-board, and fine lines drawn by a triangle, with a sharp and moderately hard pencil, perpendicular to the edge. The lines should be drawn *beyond* the edge, to make sure that they do not stop short of it; then it will be found that, on laying the slip down on a line of the drawing, the divisions may be set off on the paper or slate with perfect precision. It is not necessary to puncture the paper with a sharp point, but a fine line is to be drawn with the pencil. And we may here remark that the pricking of holes in the paper is always to be avoided when it is possible: a great many otherwise accomplished draughtsmen make use of dividers in setting off distances, when the scale or the pencil compass might as well have been used; this tends to mar the drawing, and we earnestly advise the beginner to mark off his distances with the pencil whenever he can.

Beginning with the most elementary figures, let us suppose that it is desired, first, to draw a square of a certain size. That means the drawing of two parallel lines at the given distance apart, and of two others perpendicular to them, at the same distance apart. This may be done as shown in Figs. 11 and 12. The paper scale, S, with the proposed length of the side marked off on it, is placed near the edge of the triangle B, Fig. 11, and this distance is marked with the pencil, as $l\,m$: this line may then at once be drawn. The triangle A being applied to B, as shown, is held fast, while the former is shifted into the new position shown in full lines in Fig. 12, and the paper slip again used to mark the vertical distance $l\,n$. Having drawn that line, the triangle B is moved along A to the position shown in dotted lines, when the other vertical line $m\,o$ is measured and drawn in the same way, and the square completed by restoring B to its first position, sliding it upward till the fourth side $n\,o$ can be drawn by it. We have shown the paper slip also in dotted lines in position for marking off $m\,o$, for the purpose of calling attention to the fact that it will be found convenient in many cases, such as the one here shown, to cut the slip with parallel edges, and to mark the divisions clear across it, so that its position may be reversed.

Now, it will, perhaps, be remarked, that it is not necessary to mark off the distance $m\,o$ at all, since if a vertical line be drawn through m, and a horizontal one through n, their intersection will be the fourth corner of the square. This is very true, and in a great many cases it will be found not only possible, but absolutely necessary to determine points by the intersection of two lines, whose lengths we may not know until the intersection is found. But this apparently needless measurement was not introduced without a purpose. Since in this case we do know the length of $m\,o$, it is better to mark it off, because then we can stop the line just where it ought to stop, and we thus draw just the square which we wanted to draw, and no more—we have no line to rub out. And we wish the reader to keep this in mind. Inasmuch as mechanical drawings for practical purposes are made in ink, many fall into the habit of paying no attention to the termination of their pencil-lines—they draw them recklessly, relying on the subsequent use of the india-rubber to erase all that may be superfluous. There are several reasons for not doing this; in the first place, the pencilling becomes confused by these useless lines; and if the drawing be a complicated one, their existence frequently leads to the same error in inking the lines, the draughtsman forgetting to stop his pen, because he had neglected to stop his pencil, at the right place; which is especially likely to occur if the work be laid aside for a few days, so that he in a manner loses the thread of his story. We shall take occasion to reiterate this point; but as we are now speaking of pencil-work only, it is very evident that we ought carefully to avoid the use of the rubber as much as possible; and by attention to such methods of doing it as we have above illustrated, the habit will be formed, so that in his farther progress it is hoped that the reader will not be satisfied with himself if he permits a superfluous mark to appear even in pencil.

It is not to be understood that the management of the triangles, in drawing a square, is confined to the methods shown in Figs. 11 and 12, which was first given for the express purpose of calling attention to the matter just spoken of. Another, and perhaps readier method, is shown in Figs. 13 and 14, in which the movable triangle B is simply caused to slide along the fixed one A without any other change of position—the sides $l\,m$, $m\,o$, being drawn when B is in the positions shown respectively in full and dotted lines in the first figure, $n\,o$ and $l\,n$ being drawn when B is placed as shown in the second. Nor is the construction limited to the dimensions selected for illustration. The operator will soon see that by proper manipulation he can draw a square of which the side is nearly as long as the longest side of either triangle, although it will require more adjustments and changes of position. Since, however, the operation involves nothing more than the drawing of lines at right angles to each other by the square corner of one of the triangles, and parallels by sliding one along the other, it is not necessary to devote more space to this problem.

It may, however, be worth while to observe that the accuracy of the square may be tested by means of the triangles; thus, in Fig. 13, if the diagonals $l\,o$, $m\,n$, be drawn, they will be perpendicular to each other if the square be correctly drawn; which leads us to add, that the habit should be formed of applying tests of this kind, whenever it can be done, to work as it progresses. Such checks often serve to detect errors, which might, if overlooked, impair the accuracy of subsequent operations based on those already performed.

It is also to be noted that the operation of drawing the square is purely mechanical. We assume that its sides are perpendicular to each other, because we have drawn them by a triangle whose sides are supposed to be at right angles, and it is clear that if they are not, our work will not be true.

Therefore it is proper to give here a means of testing the triangle itself, which is done by the simple process shown in Fig. 15. If we draw a line by the left-hand edge of B, when in the position shown in full lines, that line ought to be perpendicular to the upper edge of A, and the same thing should be true if we turn B over, placing it as shown in dotted lines, and draw a line by its right-hand edge. If, then, the two lines thus drawn coincide, the triangle is accurate as regards its square corner; if it be not, one of these lines will lean to the right, the other to the left. This angle being found correct, the others will be correct also, if the two short legs of the triangle are equal. The right angle of A may be tested in the same way, and if true, the others will be also correct, if the shortest side be just half the length of the longest.

Next, to draw an equilateral triangle. This is done by means of the "triangle of 60° and 30°," just mentioned. Having drawn by the edge of B, Fig. 16, a line $l\,m$ of the desired length, the triangle A is placed as shown in full lines, and $m\,n$ drawn equal to $l\,m$. On reversing A, as shown in dotted lines, and drawing by its longest side a line through l, this line should pass through n, and $l\,n$ should be equal to $l\,m$ and $m\,n$. A good test of the accuracy of this is to draw through each angle of the triangle, as shown in Fig. 17, a perpendicular to the opposite side, as $l\,o$, $m\,p$, $n\,r$; these perpendiculars should intersect at the same point c, and the points o, p, r, should divide each side of the triangle into halves, which may be readily tested by marking off, for instance, the points l, r, m, on the edge of the paper scale, and applying it to the same line in a reversed position, placing the point corresponding to m on the point l, and *vice versa*. If r coincides with its original position, the division is accurate—otherwise not.

RUSSIAN PHARMACEUTICAL STATISTICS.

SOME statistics quoted in the *Pharmaceutische Zeitung für Russland* enable us to supplement M. Mehu's article on Pharmacy in Russia with some further particulars as to the practice of pharmacy in St. Petersburg. According to the latest data, there were last year in that city 52 "free" pharmacies, having in connection with them 3 "filial" or branch establishments, two of which are carried on all the year round, and one in the summer only. Besides these medicines are supplied from the pharmacy of the "findelhause." The "free" pharmacies give employment to 4 "magisters," 74 dispensers, 934 assistants, and 77 pupils. The total number of prescriptions prepared at all the pharmacies during the year 1874 was 1,528,247, being an increase of 13,399 upon the total in 1873. The largest number of prescriptions was made up in the pharmacy of Herr Jurgens—namely, 92,964. Then came Borgmann, with 66,028; Pohl, with 57,377; Martinson, with 55,360; Wulff, with 48,155; A. Bergholz, with 47,202; Friedlander, with 44,150, and Kahn, with 40,151 prescriptions. In each of the remaining pharmacies, under 40,000 prescriptions were dispensed; eighteen pharmacies had under 20,000; and the lowest number in one pharmacy was 6791. During the year an inspection was made of all the pharmacies, but in reference to only one proprietor was any remark made by the inspection department. Finally, only one breach of the regulations for the supply of drugs was reported during the same period.—*Pharmaceutical Journal.*

FATAL EXPLOSION IN A CHEMICAL MANUFACTORY.

AN accident, resulting in loss of life, is reported as having taken place recently in the manufactory of Messrs. Gehe & Co., at Dresden. It originated in an excess of pressure being applied to a steam-jacketed copper vessel, containing about four hundredweight of a macerate of nutmegs, from which the essential and fatty oils were being separated. The pressure caused the copper vessel to burst, and the liberated vapors coming into contact with the fire, exploded with a force that destroyed the greater part of the wing of the building in which it took place. Two workmen were buried in the ruins, and when extricated were quite dead. The chemical manager had a very narrow escape. He was occupied in the counting-house when suddenly the floor of the library was driven in upon it; a bookcase fell upon him, so that he was completely buried under the books. To this circumstance he probably owed his life; for upon the removal of some of the rubbish he was found unhurt. The fire resulting from the explosion was extinguished in about an hour.

NEW STEAMER BETWEEN NEW-YORK AND THE BRAZILS.

ON the 2d ultimo, the screw-steamer Nellie Martin, built by Messrs. Raylton, Dixon & Co., of Middlesborough, Eng., for the Star Ball Line, took her official trip from the Tees to the Tyne, and although the weather was very strong, an average speed of eleven knots was obtained. Her dimensions are: Length, 286 feet; width, 34 feet; depth of hold, 25 feet; classed 100 A 1 at Lloyd's, three-decked, schooner-rigged, fitted with water ballast, steam winches, patent windlass, and other recent improvements. She has a saloon on deck for sixteen first-class passengers, with sleeping-berths below; her engines are of 180 nominal horse-power, by Messrs. T. Richardson & Sons, Hartlepool. This vessel is intended to trade between New-York and the Brazils.—*Iron.*

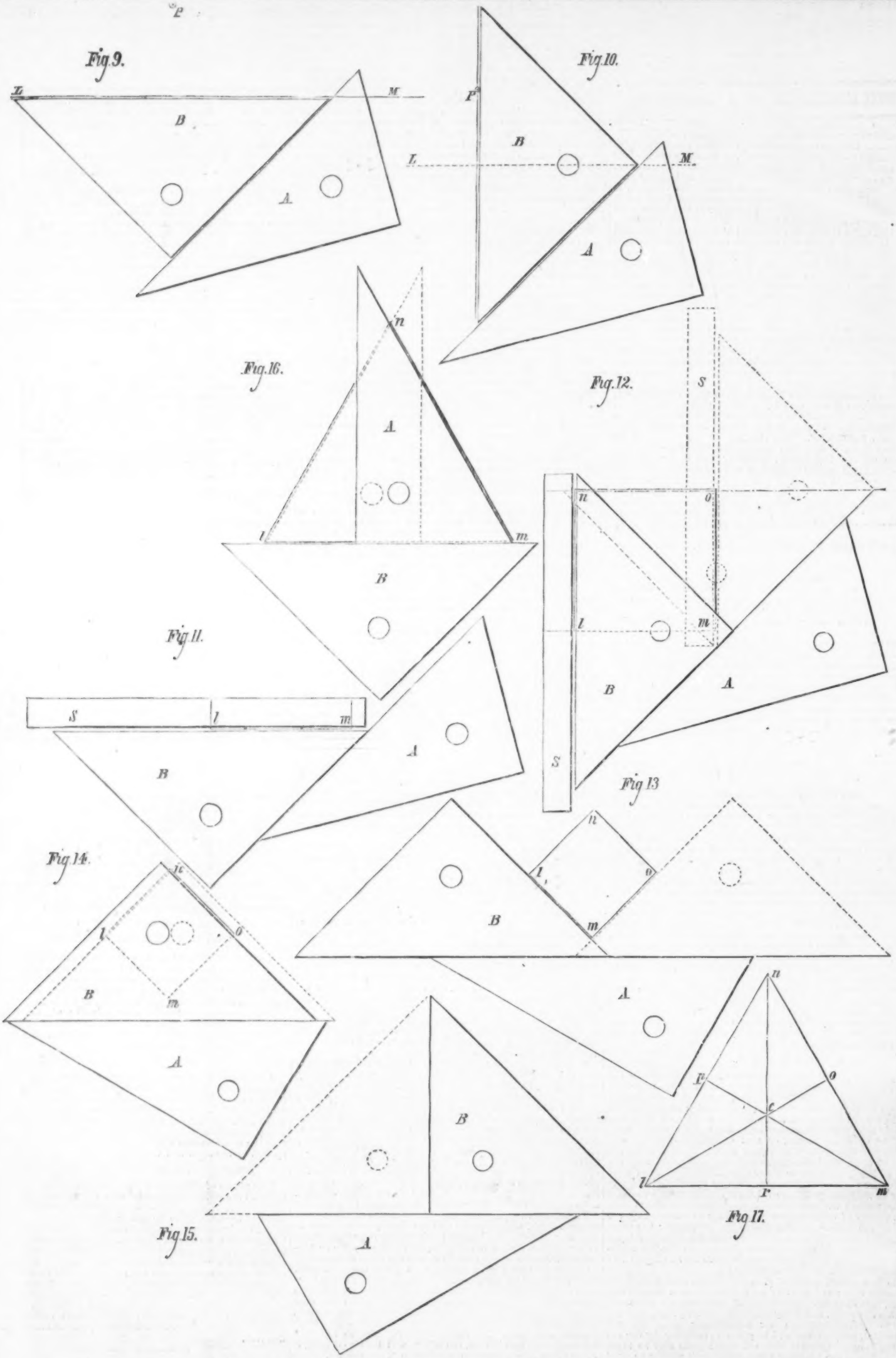
GERMAN IRONCLADS COMING.

A GERMAN ironclad fleet will visit American ports this year. It had been determined by the German authorities, even previous to the appearance last June of the Franklin and the Alaska in German waters, to return the visit of the Miantonomah and the Augusta, which took place in 1866, and hence, should no preventive circumstance arise, our Centennial will be honored with the presence of several German men-of-war. It is as yet undecided whether the Crown Prince will accompany the fleet.

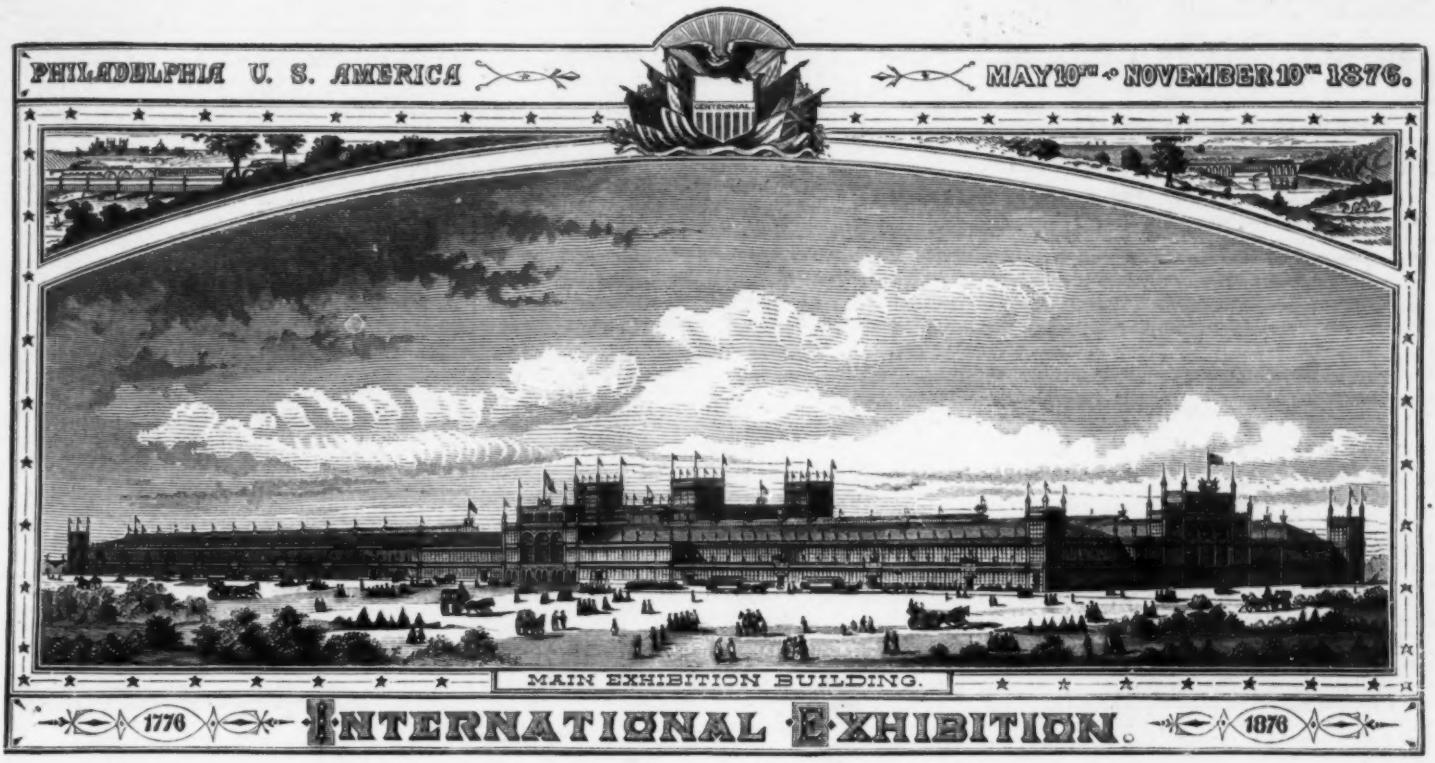
A BALLOON which made a scientific ascent from Paris on December 8th, suddenly fell to the ground when it had reached a height of two hundred and thirty metres. All the occupants of the car were more or less injured, but no one was killed. The balloon fell in a market garden at Vincennes, which fortunately had been freshly dug up. It is said that the accident was due to the silk of the balloon being spoiled by the snow and the hard frost.

THE plants of *Eucalyptus globosus* introduced some years ago into the Roman Campagna, with the object of neutralizing the miasmatic emanations which make the district so unhealthy, are reported to be in a thriving condition. It is believed that there are already indications of some special action by the trees upon the atmosphere. At any rate they will by their mere growth consolidate and dry up the marshy soil for some distance round, and that alone will have a beneficial effect. Some confirmation has also, it is said, been obtained of the belief common in Australia that a decoction or extract of the leaves of the Eucalyptus is a remedy and prophylactic against the type of disease which has for ages rendered a large part of the Campagna uninhabitable during certain seasons, and caused to inconsiderable portion to be altogether deserted.

CHEMICAL NATURE OF SALYLIC ACID.—H. Kolbe, in *Moniteur Scientifique*, states that salylic is merely benzoic acid contaminated with a very small amount of a foreign body not yet determined.



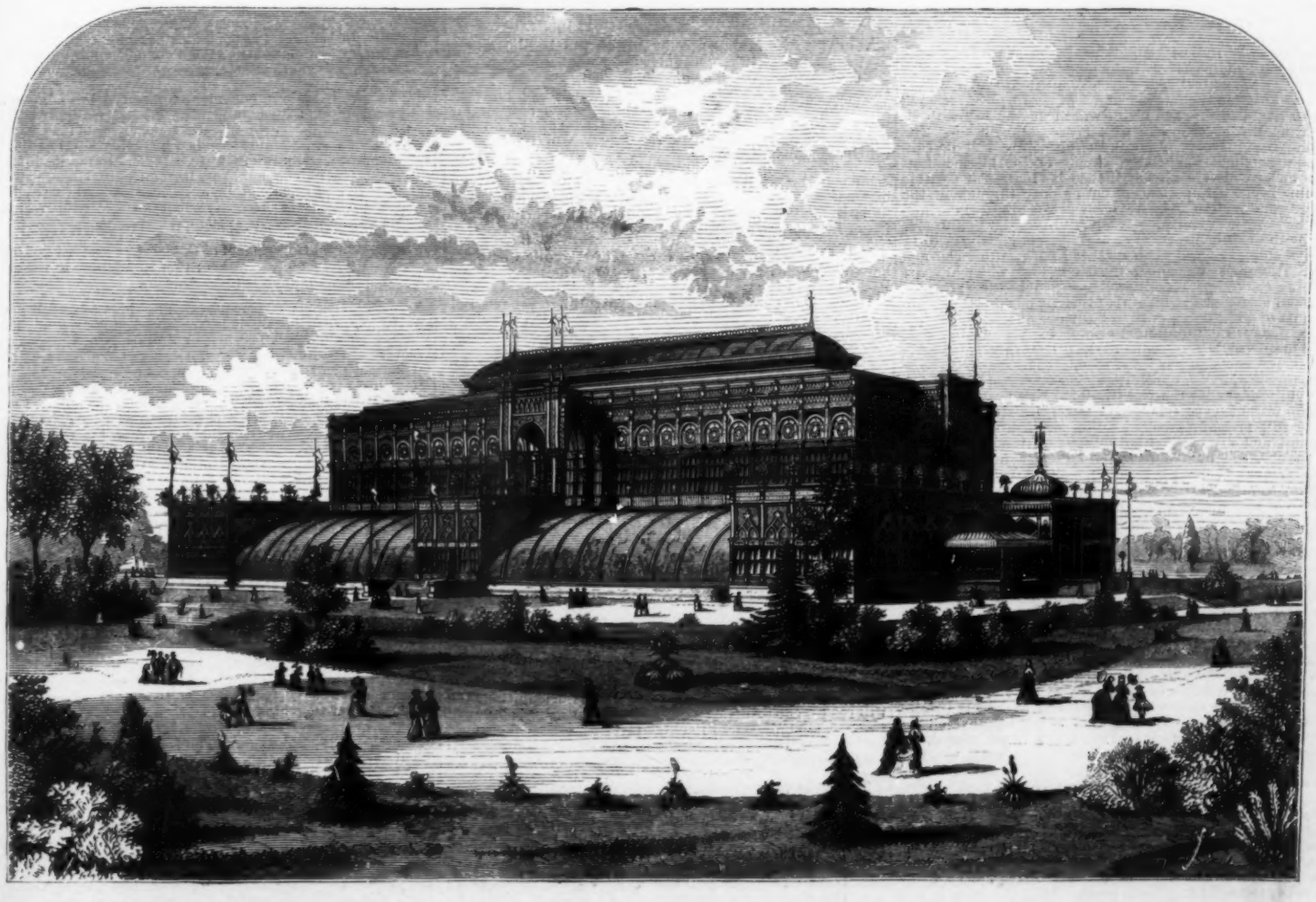
LESSONS IN MECHANICAL DRAWING.—(*See page* 35.)



THE INTERNATIONAL EXHIBITION OF 1876.—ELEVATION OF THE MAIN EXHIBITION BUILDING.—(*See page* 40.)

THE WESTMINSTER CLOCK.

SIR EDMUND DENISON, the designer of the Westminster Clock, London, lately gave a sort of "clinical" lecture upon it to the members of the Horological Institute, of which he is president. The clock-room, a lofty chamber, 28 ft. by 18 ft., was well filled. The clock being made in 1854, the address, it was expected, would have been in celebration of its coming of age, but no allusion was made to the coincidence. The lecturer, who spoke without notes, gave a short history of the difficulties incident to the construction of a striking clock on a larger scale than had ever been attempted, and doing a great amount of work. The lecture was delivered from behind the clock itself —the frame of which is nearly 16 ft. long by 4 ft. 7 in. wide, the flies revolving some twenty feet overhead. The winding of the striking part, which is done by hand, is contracted for at £100 a year. It takes place twice a week, and lasts five hours at each operation. The first stroke of the hour is given when the clock reaches the 60th second of the last minute of the hour preceding, the fourth quarter being let off about twenty seconds before the hour, so that it has finished before the hour begins. Two points in particular interested the audience—the gravity escapement and the pendulum. The lecturer stated that a very large arc, 2¾ degrees each side of zero, had been adopted for the pendulum, to regulate it for differences, not of temperature, but of barometric pressure. In this system of regulating for barometric pressure, the lecturer stated, errors vary inversely as the cube of the arc. The lecture, which lasted over five quarter hours, gave an opportunity of observing the noiseless working of the machinery. At its conclusion, the lecturer, in reply to thanks, urged in forcible terms the regulating of post-office clocks by the Government for the public convenience. Most of the party visited the bell-tower overhead before descending.



THE INTERNATIONAL EXHIBITION OF 1876.—ELEVATION OF THE HORTICULTURAL HALL.—(*See page* 40.)

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HOW THE CENTENNIAL YEAR FINDS THE WORK OF PREPARATION.

IN the early part of December, the *Nation's* correspondent in Philadelphia made a careful inspection of the Centennial grounds and buildings. Below we give the principal portion of his report. With the proviso that the anticipated speedy completion of the unfinished buildings has been justified by the event, his review of the work will stand as an accurate description of its condition at the beginning of the Centennial year:

The Machinery Hall is finished, and has been formally handed over by the contractor to the general direction. Workmen are now laying the foundations for the huge Corliss engine in the centre that is to supply the motive power to the shafting. The tanks and reservoirs for the department of hydraulics—by the by, omitted at Vienna—are either finished or well under way. Several of the supply-boilers are on the ground. The flooring is laid, except in places reserved for the foundations of heavy machinery. A surveyor is now engaged in marking out on the floor the spaces for different exhibits. The view from the upper gallery at the end of the hall is even now impressive. One can take in at a glance its magnitude and handsome proportions, and above all its adaptation to the purpose for which it is built. It is beyond question the finest machinery hall yet erected, and when filled and in operation will surpass London, Paris, and Vienna. The light is excellent, and the general appearance is that of neatness. It is in every respect a marked contrast to the ungainly, untidy structure in the Prater, and is worthy of the nation whose industry it is intended to display.

The Main Building is not so far forward, but the work that remains is inconsiderable in amount and of an easy kind. The building, as a building, is completed, but the flooring is still to be laid in great part, and the decorative painting of the interior is not yet begun. It will be pushed vigorously as soon as the committee have decided upon the pattern and color. Several columns and panels have been ornamented as samples of the various styles from which the selection is to be made. Six or eight weeks of quiet, regular work will probably suffice for the completion. There is no danger of interruption from the weather, as the outer walls and roofing are finished.

The Memorial Hall or Art Building is about as far advanced as the main building—that is, the outer walls and roofing are done, with the exception of the cupola, where the workmen are now fitting in the few remaining panes of glass. In the interior the plastering and flooring are being pushed with as much rapidity as comports with good workmanship. The building being heated by steam the plastering will be continued throughout the winter. Many of the black-walnut doors and panels are already finished. Inasmuch as this building is not only permanent but fireproof throughout, the construction materials being exclusively brick, stone and iron, its growth is truly remarkable. Every thing indicates that by the end of February or beginning of March it will be "swept and garnished" and awaiting the pictures and statues. Those who remember the agony with which the Art Building at Vienna was literally rushed in the spring of 1873 will be pleased to learn that there is no danger at Philadelphia of a like overhaste and tardy opening.

The Horticultural Building, also permanent, is finished, and indeed partly occupied. At least one of the galleries is heated, and contains some fine specimens of orange-trees in fruit, cactuses, india-rubber trees, and other hot-house flora. The steam-pipes for the main hall are very nearly in order, and the workmen are arranging the soil for the beds. The visitor will probably pronounce this Horticultural Hall the prettiest and most attractive building on the grounds. Its dimensions, 383 by 193 feet, are larger than those of the palm-house at Vienna; it is better planned, and the decorations—polychrome frescoes and arabesques in the Moorish style—are charming. In its grace of contour and warmth of color it will afford a pleasing counterpart of the Renaissance lines of sober hue of the Art Building.

Agricultural Hall is the most backward of all. It met with a slight mishap early in the fall, the first few arches being blown down by a sudden gale before they had been fairly propped and stayed. But this accident has been promptly repaired, and the work since then has progressed at an extraordinary rate. Those who visited it only six weeks ago declare that it has grown like a mushroom. The simple nature of its structure explains the phenomenon. It consists of a nave, 820 feet in length, crossed at right angles by three transepts, each 540 feet in length. The framework of nave and transepts is a succession of slight and extremely pointed Gothic arches of wood. The arch is put together on the ground. When finished it is raised into position, shored, and attached to the arches already up by beams, upon which is laid the roof. About two-thirds of the arching is up, and for the most part roofed. Should the present mild weather continue, arching and roofing may be completed by the end of the year; a good deal will still remain to do. Each of the eight ends is to be flanked by towers, making a sort of façade, and the central point of the building is to be crowned by a tower. The spaces between the transepts (outside of the nave) are also to be covered over by secondary arches, parallel to the transepts but much lower. Still, the work is well in hand and need not be suspended, except in very heavy snow or rain or extreme frost. At all events, Agricultural Hall is considerably in advance of the agricultural buildings at Vienna. In general, I feel no hesitation in saying that the Philadelphia Exhibition has a start of at least three months over its predecessor. I base the assertion upon the impression that I obtained during a week's visit in Vienna at the end of January, 1873. No one of the great buildings there was at that time as far on as the corresponding building now is at Philadelphia.

What is true of the buildings is equally true of the grounds. The walks, drives, artificial watercourses and lakes, the grading, sodding, and garden work, at the Centennial, are all that the friends of the enterprise can desire. The grounds have great natural advantages which make them much superior to the Prater inclosure. They are high, well drained, properly diversified, and decidedly picturesque. In one or two places they are intersected by ravines varying in depth, to be spanned by rustic bridges. From the eastern side one has charming views of the Schuylkill valley here and there. George's or Reservoir Hill, on the west, overlooks the ground and buildings. Near this point has been erected a tall lookout tower, ascended by a steam elevator. From the top there is a superb panorama of river and city. The Main Building and Machinery Hall are in a line forming the southern boundary, the others are dotted somewhat irregularly over the grounds to north, east, and west, and present a very agreeable diversity of lines and angles. The central point is near the southeastern end of the United States Government Building. Here the principal walks intersect, and from here the eye can sweep over the great buildings ranged around. Unless we have an exceptionally severe and protracted winter, I see no reason why the Centennial may not be opened, according to programme, on the 10th of May, with turf and flowers and walks and the other paraphernalia of landscape gardening as far advanced as they were at Vienna by the end of June.

I may add that the building for the exhibition of the several departments of the National Government is almost finished. Some pieces of heavy artillery are already in position outside. The officers of the English and Japanese Commissions are under roof, and the same may be said of four of the five large restaurants on the grounds. The track of a narrow-gauge dummy railroad to encircle the buildings and carry visitors from one to the other is partly laid.

EXHIBITION NOTES.—FOREIGN.

THE list of exhibitors in the British section has been published. It embraces fully seven hundred names, representing almost all the leading manufacturing firms in the United Kingdom. It is expected that the display of machinery, fire-arms, cutlery, woolen cloths, yarns, etc., and linen will be very large and extremely attractive. London, Sheffield, Glasgow, Birmingham, Manchester, Liverpool, Huddersfield, Belfast, Dublin, and Leeds will be particularly well represented. Prof. Archer, Director of the Edinburgh Museum, has been appointed as Centennial Commissioner, P. Cunliffe Owen having resigned.

A LARGE and varied display of French products is expected, as space has been allotted to more than two thousand applicants. The municipality of Paris has contributed $6000 towards the subscription to send a deputation of French workmen to the Exhibition.

AMONG the articles to be contributed by Germany, is a collection of apparatus illustrating the treatment of the wounded in time of war. The Empress Augusta herself is supervising the composition of this display with the same zeal she manifested when the ambulance bureau was being organized for the Franco-German war.

HOLLAND will exhibit a collection of models illustrating the progress made in that country in hydraulic engineering. The great works undertaken by the State will be represented, among them the Haarlem drainage, the new canal, the Dordrecht steel bridge, the Kuilenberg Railway, a new steam-pump, copper models of sluices, a relief map of the Zuyder Zee, etc. Another feature of the display will be a model Dutch school-house.

SIGNOR BLANC, Italian Minister at Washington, has been nominated Centennial Commissioner. There have been six hundred applications for space in the Italian department, the larger number for works of art.

ONE hundred and forty-two cases of Egyptian exhibits have already been shipped, and the Commissioners of the Pacha are on their way to this country. Six thousand square feet have been assigned to Egyptian antiquities. Paradoxical as it may seem, this portion of the Exhibition will doubtless be exceedingly new and instructive.

MEXICO will also make a fine display of antiquities, including models of the more remarkable Aztec and other temples and palaces, specimens of Indian feather robes and pictures, and many other curious relics. Great preparations are in progress to have the country well represented.

INFORMATION has been received in Washington that the Emperor of Brazil expects to start for the United States in April, intending not only to visit the Exhibition, but to travel over much of our country for pleasure and instruction. Brazil was one of the first nations to accept the invitation to be represented at the Centennial Exhibition.

SEKIZAWA AKEKIS, Executive Commissioner for Japan, reports a greater interest among his people for the Centennial than for any preceding exhibition. A fine exhibit may be expected. The Government has added to its appropriation of $600,000 for the official display of the resources of the country the sum of $80,000 for the encouragement and assistance of meritorious exhibitors. A large space will be occupied in the main building, in the Agricultural building, and in a special bazaar, for the exhibition of Japanese wares, by attendants in native costume. The display in the main building will consist chiefly of lacquers, bronzes, porcelains, silks, and teas. A Commissioner in charge of thirteen artisans arrived in San Francisco, December 21. They brought the material for the Japanese government buildings.

THERE is a promise that an elaborate model of the Suez Canal will be sent to the Centennial Exhibition, either by its projector, Ferdinand de Lesseps, or by the Khedive, as part of the Egyptian collection. The model is said to be a beautiful specimen of workmanship, representing not only the topographic features of the canal and the adjacent country, but also the various mechanical appliances used in the construction and operation of the work—locks, dredges, machinery used in the manufacture of artificial stone for the piers at Port Said, etc., etc.

SPAIN will be represented in this country by the following commissioners, who have already arrived: Col. Lopez Favra, Chief Commissioner; Signor Alvaro de la Tandara, Director of the Department of Industry; Count del Donadio, Director of the Department Fine Arts; Don Joaquin Oliver, Secretary-General; and Alfredo Escobar, Secretary. Col. Favra says that it is the intention of Spain to have a larger representation than at any previous exhibition, which is promising a great deal, as it will be remembered Spain carried away more medals and diplomas from Vienna than any other country. There will be samples of every kind of Spanish machinery, industrial and agricultural implements and products, mineral products, a fine collection of antiquities, and a large number of photographs illustrative of the costumes of the different provinces, town and country life, etc. There will also be a full display of the products of Cuba and the Philippine Islands.

ALL the principal cities of Italy have agreed to co-operate in securing an adequate exhibition of Italian products at Philadelphia.

The Central Committee in Florence, which will act in concert with the Ministers of Agriculture, Industry, and Commerce, consists of Guiseppe d'Assi, President; Professor Salvatore Mazza, Vice-President; Francesco Barzaghi, Vespasiano Bignanie, Luigi Blanchi, Baron Eugenio Cantoni, Giovanni Spertini, Giacomo Cattadori, Secretary. The presidency of the Executive Committee of this commission has been given to Signor Padovani. The representations of painting and sculpture will be very large. Exhibits will also comprise oil, wine, liquors, cheese, rice, maccaroni, dried fruits, sulphur, porcelain, terra cotta, coral from Naples, lava from Pompeii, glass from Venice, filagree works from Genoa, and mosaics from Rome. There will be a large display of chemical products, colors, etc. The general agent for the Centennial Commission, who will be stationed in Philadelphia, is Signor Cavaliere A. M. F. Giannelli, Italian consul at Montreal.

The Pope has formally accepted the invitation of the Centennial authorities, and has promised to contribute works of art from the galleries of the Vatican, and articles from the papal work-shops.

SIAM has appropriated about $100,000 for a display of its products and industries, and the goods are on the way in charge of John H. Chandler, an American citizen who has been appointed Commissioner for the kingdom.

FRANCE has applied for space for the exhibition of Gobelin tapestry and Sevres china; also for space in the Art Gallery for two thousand pictures. The French exhibitors talk of putting up a conservatory and a building for a collective exhibit of bronzes.

BELGIUM asks for 9000 square feet in the Art Gallery, and the Argentine Republic wants 500 square feet in the same building. Brazil has voted $150,000 for its representation.

THE Danish preparation for the Exhibition is well advanced. It consists chiefly of gloves, sewing, twisting, and writing machines, boots and shoes, leather, terra cotta, photographs, liquors, cards, wax candles, safes, transportation appliances, belt gearing, furniture, jewelry, silverware, sculpture and paintings.

PORTUGAL is making preparations to be represented in a proper manner at the Centennial celebration. The Department of Marine and Colonies is engaged in organizing a complete collection of the various products to be found in the Portuguese possessions. The Central Association of Portuguese Agriculture, in session at Lisbon, has been officially invited to collect the best specimens by which the actual state as well as the progress of agricultural industry might be best known. The Directors of the Industrial Institutes of Lisbon and Oporto are deliberating concerning the best means for representing Portugal at the Centennial Exhibition. The collection of all the articles that may be of general interest has received the special attention of the Minister of Commerce.

JAPAN'S contributions, now at sea, comprise the following classes of objects: Ores, minerals, flowers, fruits, woods, varnishes, tea, tobacco, wine, vinegar, sugar, lacquered ware, porcelain, bronzes, metallic inlaid work, cabinet ware, inlaid woods, bamboo ware, rattan ware, silk and cotton manufactures, embroidery, raw silk, fur, leather, engravings, paper, fans, fishing implements, toilets, curiosities, scientific appliances, collections from government departments (coins, weights and measures, postal stamps, maps, etc.)

THE Provincial Government of Ontario has granted $22,000 for promoting its representation; this in addition to the appropriation by the Dominion Government.

THE contributions of Nova Scotia are likely to be full and interesting. To ascertain how the representation compares with what was done at previous exhibitions, Dr. Honeyman, Secretary of the Advisory Board, has prepared a comparative statement which shows that the collection to be forwarded to Philadelphia is far superior in size and importance to that which was sent to London. The production of the mines of the province, its manufactures and fisheries, will be more fully illustrated than ever before, while many branches of industry will be represented for the first time. There are about seventy entries, exclusive of those to be made by the Fruit Growers' Association and the Ladies' Department.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY. LONDON, DECEMBER, 1875.

PROFESSOR ABEL, F.R.S., President, in the chair. The first paper, "On the Decomposition of Alcohol and its Homologues by the Joint Action of Aluminium and its Halogen Compounds," by J. H. Gladstone and A. Tribe, was read by the former. When iodine dissolved in absolute alcohol was poured on finely-divided aluminium a powerful action takes place, and hydrogen was evolved in abundance. The pasty residue in the flask, when heated to 100° C., gave off alcohol, and left a solid residue, which, at 275° C., became liquid, alcohol and an oily body containing iodine passing over. The fused residue in the flask, when heated to a still higher temperature, was decomposed with formation of alcohol, ethylen, and alumina; but under diminished pressure a different result was obtained—a greenish white solid sublimed, which, on analysis, was found to be aluminic ethylate, $Al_2(C_2H_5O)_6$. This is the second instance on record of an organo-metallic body containing oxygen which is capable of distillation, cacodylic oxide being the other. Similar results were obtained with aluminic iodide or aluminic bromide, and aluminium was employed instead of aluminium and free iodine, but the action was less energetic. Amylic alcohol acted in the same way as ordinary alcohol.

Mr. C. E. Groves then read a "Note on Incense Resin," by Dr. J. Stenhouse and himself. This resin, which is the produce of a tree indigenous to British Guiana, and is also known as "Gum Hyawa," or resin of Conima, contains, besides an essential oil, a crystalline and a non-crystalline resin. The essential oil, which is extracted in the usual way by distillation in a current of steam, has the empirical formula, C_5H_8, and appears to belong to the $C_{15}H_{24}$ group. Conimene, which is the name the authors have assigned to it, boils at 264° C., and possesses a pleasant aromatic odor. It is polymerized by the action of sulphuric acid. The crystalline resin forms minute colorless needles of the composition $C_{10}H_{17}O$. It melts at 175°, and is but moderately soluble in boiling spirit.

Mr. J. Spiller read a notice "On the Occurrence of Native Calcium Chloride at Guy's Cliffe, Warwickshire." In the course of a tour through Warwickshire, the author visited Guy's Cliffe, and on several parts of the face of the low sandstone cliff there he noticed a black slimy exudation, as if it had been bedaubed with tar, and some of this black slime was collected for examination. The results of the analysis, which was rendered somewhat difficult by the presence of dead leaves and stalks and living algæ, were given, and showed the presence of a very large percentage of calcium chloride. This material, as it is washed away by the rains, is constantly renewed, and would seem to point to the existence of salt-beds in the neighborhood.

The Chairman, in thanking the author, remarked no doubt there were many other gentlemen present who, like himself, had visited Guy's Cliffe without noticing this interesting substance to which Mr. Spiller had directed their attention.

Dr. Thudicum said it would be interesting to know to what geologic period the sandstone belonged, as a considerable bed of sandstone had to be penetrated at Stassfurt before the salt-bed was reached, and a substance very similar, he believed, to that examined by Mr. Spiller, had led to their discovery.

In reply to a question by Mr. T. B. Groves, the author said the apparently black color of the specimen was due to the dark green of the algæ present, mixed with decomposing organic matter.

Mr. G. S. Johnson then communicated a note "On Certain Sources of Error in the Ultimate Analysis of Organic Substances containing Nitrogen." The author, whilst making a combustion of an albumenoid substance with lead chromate and freshly reduced metallic copper, was anxious to ascertain if any nitrous acid had escaped reduction, and on testing the contents of the potash bulbs obtained abundant evidence of the presence of nitrous acid. On examining the original solution of potash, however, it was also found to be contaminated with potassium nitrite. This is likely to be a source of error in the carbon, as such potash absorbs oxygen, and increases in weight when a current of dry pure air is passed through it. Another source of error is the occlusion of hydrogen by metallic copper which has been reduced in a current of dry hydrogen, even if it be subsequently heated to 150° C., rendering the hydrogen determination too high.

Dr. Wright said he could confirm Mr. Johnson's account of the occlusion of hydrogen by copper, for he had always observed, with nitrogeneous substances burnt with lead chromate and metallic copper, that the hydrogen came about 0·5 per cent too high, whilst the excess in ordinary non-nitrogeneous substances was only about 0·2.

Dr. Voelcker said he would like to point out certain sources of error in the determination of nitrogen in highly-nitrogeneous bodies, especially albumenoids, if the combustion was not performed with sufficient precautions. In the first place, it was necessary to have the substance very finely divided and intimately mixed with the soda-lime; otherwise, the nitrogen would be too low. Again, hydrogen may not be present in sufficient quantity to cause all the nitrogen to be evolved as ammonia; but this source of error might be avoided by mixing sugar with the substance. A third cause of error was the employment of too high a temperature, as in the extreme heat of a Hoffmann's gas-furnace, when the nitrogen was apt to be partly dissociated into its elements; the combustion should be performed at a dull red-heat. This loss was increased if too long a tube were used, or if the mixture was burnt too slowly. If nitrates were present along with albumenoids, it was necessary, in order to obtain accurate results, to wash out and determine the nitrates and ammonical salts, and then burn the albumenoids in the usual way.

Dr. Armstrong said he could confirm the observation about the occlusion of hydrogen by metallic copper, for in the combustion in a vacuum, after a good one had been obtained by the Sprengel pump, as soon as the copper was heated the vacuum diminished, showing that gas had been given off. He found it advantageous to substitute silver for copper, which answered admirably if strongly heated.

A paper "On Certain Bismuth Compounds," by Mr. M. M. P. Muir, was then read. When bismuth is heated in a current of chlorine, the two unite, and a beautifully crystallized sublimate of the trichloride is obtained. It melts at 225° to 230° C., and may be distilled unchanged in a current of dry carbonic an hydride. The tribromide was prepared in a similar way, but forms flat, brilliant, yellow crystals, which melt at 210° to 215° C. The author has studied the action of water and of ammonia on the tribromide, and gives details of the results obtained, as also of the preparation of the so-called bismuthic acid by passing chlorine through bismuthous oxide, Bi_2O_3, suspended in a boiling solution of caustic potash. It still retains traces of chlorine, however, but this may be removed by boiling the chocolate-red product with strong nitric acid, which changes it to a brilliant scarlet. It then has the composition $HBiO_3$, but when heated to 120° C., it loses water, and leaves bismuthic oxide, Bi_2O_5. The attempts to obtain salts of bismuthic acid failed.

The last communication was "On Bismuthiferous Tesseral Pyrites," by Dr. W. Ramsay. It contains the results of the analysis of a specimen of this mineral from the museum of Glasgow University. The formula deduced is $(Ni,Cu,Fe)(AsBi)_2$.

PHYSICAL SOCIETY. LONDON, NOVEMBER, 1875.

PROFESSOR G. C. FOSTER, F.R.S., Vice-President, in the chair. Professor Guthrie briefly described Dr. Kerr's recent experiments to show that glass, resin, and certain other substances exhibit a depolarizing effect when under the influence of powerful electrical tension, and he exhibited the arrangement of apparatus employed in the research. He also showed certain experiments connected with the investigation

STATIONARY LIQUID WAVES.—Dr. Guthrie then made a communication on "Stationary Liquid Waves," in continuation of that which he made to the Society in June last. If water in a cylindrical vessel, not less than nine inches in diameter, be agitated by depressing and elevating a flat circular disc on its surface at the centre, a form of oscillation is set up which the author terms "binodal." He finds that these fundamental undulations in an infinitely deep circular vessel are isochronous with those of a pendulum whose length is equal to the radius of the vessel; and further, a fact which is extremely interesting, that the motions of the pendulum and water keep together throughout their entire paths. An arrangement was exhibited for experimentally demonstrating these facts. To the upper end of a short pendulum with a heavy adjustable bob is attached a cardboard sector in the plane of vibration of the pendulum. A silk thread attached to the edge of this sector carries a small paraffin disc, which rests at the centre of the surface of the water contained in a cylindrical vessel. The pendulum-length is adjusted until the motion of the disc is isochronous with that of the water when the two are not in contact. Two other forms of motion may be produced in cylindrical vessels: namely (1), by alternately compressing and extending opposite ends of a diameter, as in the motion of a bell—this gives two diametral nodes at right angles to each other—and (2) by rocking the vessel, which gives a single diametral node. Each of these has its own period of vibration, the last being the slowest. They may be superimposed on each other; and a rotation of the water, however great, does not interfere with their formation. In rectangular troughs a binodal and a mononodal wave system may be established. The former is induced by raising and depressing a wooden lath at the middle of the surface, and the latter by tilting. Binodal vibration in a circular trough may be compared with a vibrating pair of triangular laths; and in rectangular troughs with the balancing of two rectangular laths. In this latter case the nodes are at quarter of the trough's length from each end. Some discrepancies are met with when we compare times of vibration in rectangular troughs of various lengths, and these are due to a scraping action which takes place against the ends of the vessel. The result of the experiments on binodal motion in rectangular vessels is to show that the undulations are isochronous with the oscillations of a pendulum whose length is 2·11 times that of the trough. The chief points in connection with this subject to which the author referred as still requiring explanation are: (1) Why are the motions pendular? (2) How is it that in circular binodal motion the times are identical with that of a pendulum of the given length? and (3) What is the mathematical connection between the individual motion of each particle and that of the mass? Mr. Lodge thought that valuable results might be obtained by treating the mass of moving water as a pendulum with two bobs oscillating about the node. This might be specially useful with small oscillations when the surface is practically plane.—*The Academy.*

IMPROVEMENTS IN THE PACKING OF RAW COTTON.

MR. R. WILSON, of the firm of Messrs. Nasmyth, Wilson, & Company, Bridgewater Foundry, Patricroft, who for many years past has devoted considerable attention to the perfecting of his hydraulic presses for the packing of raw cotton for shipment, has just patented a further improvement which will tend greatly to facilitate the operation of baling the fibre on the plantation where it is grown. By the earlier methods the packing of the cotton was performed in a vertical press, containing a long narrow trunk or cotton box, which was filled in from the top, and the cotton stamped down by the men, the necessary pressure for reducing the fibre to the size of the bale being afterwards applied by hydraulic rams worked upwards from the lower end of the trunk. This machine, however, although it occupied comparatively little ground space, necessitated the erection of a two-storied building, the hydraulic rams being worked in the bottom story, and the filling in of the cotton being carried out in the second, whilst the operation itself was not so expeditious as could be desired. In November, 1873, Mr. Wilson patented an improvement upon this method, by which he did away entirely with the necessity of an expensive structure, the machine requiring only the most ordinary shed, which is a great consideration in up-country establishments, and at the same time greatly facilitated the operation of packing. This improvement consists in placing the working parts of the machine horizontally on the floor of the shed, and in reducing the length and increasing the depth of the trunk or box in which the cotton is placed before compression, whilst the preliminary compression prior to the application of the hydraulic rams, instead of being performed by the men stamping down the cotton, is effected by a weighted box suspended above on two double rods, and worked upon by a small hydraulic ram, and forming the upper side of the trunk. The mode of operation in this machine is as follows: The weighted box being suspended on the double rods, above the upper side of the trunk, the sides of which are made about twice the height of the depth of the bale, is left open, and the cotton is filled in to the top, the box is then lowered to the position required to form the thickness of the bales, and is then secured by shot bolts. Compression is then given by the centre of three hydraulic horizontal rams acting upon the follower until the resistance becomes too great for it, after which the final compression is given by the combined action of all three rams. When the cotton has been sufficiently compressed to hold it in form, the plate or box is raised, a couple of angle doors forming a portion of the upper sides of the trunk are opened, and a trap door forming the bottom of the chamber in which the bale is finished is released, and the bale can then be lashed in the ordinary manner. When the bale is completed the pressure of the rams is removed, the follower is withdrawn, and the finished bale dropped on to a trunk below. The rams with follower are now brought back into position, and the trap and angle doors forming the bottom and upper side of the machine being closed, the press is again ready for filling, the whole operation occupying about five minutes. This invention, though a considerable improvement upon the existing appliances of the kind, possessed a drawback, in common with them—viz., that the guiding pillars, and other apparatus connected with the working upwards and downwards of the weighted box, impeded the freedom of the men in the preliminary operation of loading the trunk. This obstacle Mr. Wilson has succeeded in overcoming by a simple contrivance, which is contained in the further patent to which we alluded at the outset of this notice. This improvement consists in, that instead of the descending box falling vertically upon the loose cotton in the trunk, the preliminary pressure required to form the thickness of the bale is effected by a weighted plate, made to work after the manner of a lid hinged on to the end of the cotton box, and worked upon by a small hydraulic ram placed parallel with the bed of the machine, and above the three powerful rams for effecting the final compression. By this means the space occupied by the machine is reduced, considerable material is saved, increased power is gained, and the trunk is perfectly open on three sides, whilst the operation is performed in less time. The improved machine, which has only just been completed at Messrs. Nasmyth & Wilson's works, has undergone a very satisfactory trial before a number of gentlemen interested in the cotton trade, and there is little doubt that it will prove of value in plantations lying long distances from the ports for shipment. We may add that the hydraulic compressing rams work up to a pressure of 1100 tons, and the bales, weighing from 3½ cwt. to 400 lbs., are reduced to eight cubic feet, from a space of 90 cubic feet occupied by the loose raw fibre.—*The Engineer.*

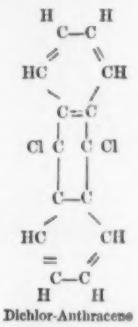
ALIZARIN FROM ANTHRACEN-SULPHO-ACID.

By G. AUERBACH.

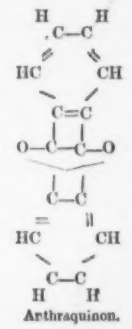
AMONGST the patents taken out up to the present time for the manufacture of artificial alizarin, there are three by which one obtains anthraquinon-sulpho-acid by oxidizing anthracen-sulpho-acid. It is thought that these methods simplify the old methods (oxidation of anthracen into anthraquinon), and are not used because our raw materials are not to be obtained pure enough; but, I think, if we could obtain in quantity a chemically pure anthracen, it would not be theoretically possible to obtain alizarin by these methods.

My reasons for thinking so are the following:

If anthracen is treated with chlorine, one obtains a body which contains, instead of two hydrogen atoms, two atoms of chlorine (dichlor-anthracen). With any oxidizing agent—chromic acid, peroxide of manganese, etc.—we obtain chlorine and anthraquinon; therefore, we see that chlorine is eliminated and oxygen takes its place, which shows that the chlorine in the dichlor-anthracen must take the place of the oxygen in the anthraquinon, as the following formulæ show:



Dichlor-Anthracene



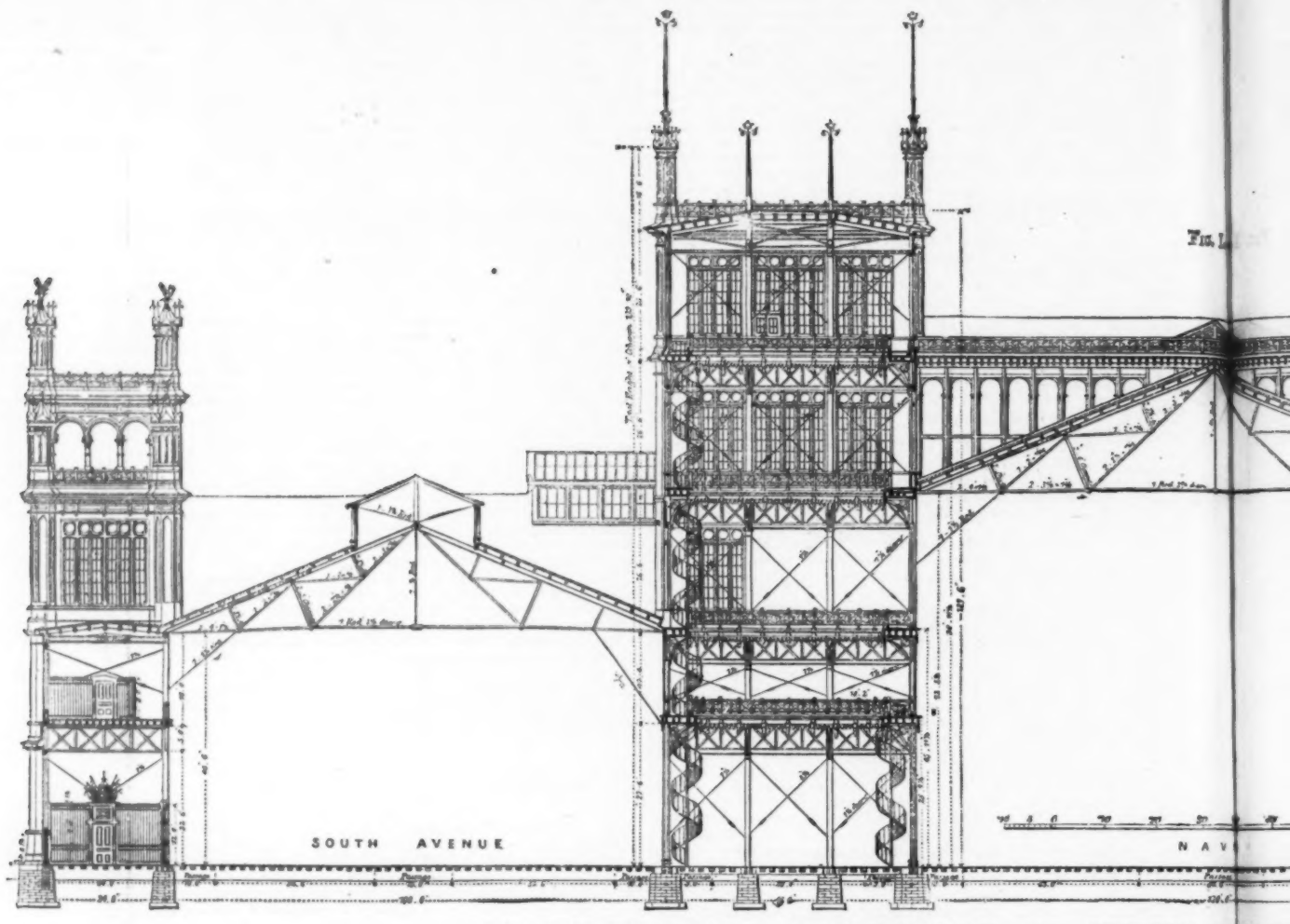
Arthraquinon.

If we treat this dichlor-anthracen with sulphuric acid, we first obtain, as Perkin shows, a dichlor-sulpho-anthracenic acid, which, by further treatment with sulphuric acid, oxidizes the chlorine atoms, oxygen takes the place of chlorine, sulphurous acid is given off, and we obtain anthraquinon-bisulpho-acid.

If we oxidize anthracen-sulpho-acid, we do not get anthraquinon, but an anthraquinon-sulpho-acid. We have no reason to think that sulphuric acid takes any other place in the anthracen than the chlorine, and that, in oxidizing anthracen-sulpho-acid, the sulphuric acid changes its place for oxygen. On the contrary, the oxygen must have another position in this anthraquinon-sulpho-acid than in that obtained by treating anthraquinon with sulphuric acid. The first anthraquinon-sulpho-acid can not be identical, but only isomeric, with the anthraquinon-sulpho-acid obtained from anthraquinon and sulphuric acid. One does not obtain alizarin from one of these methods; one obtains red sulpho-salts, and, by melting with potash, a violet melt, which, after precipitation, contains only slight traces of color, and settles, after standing, as a dark brown smear, which melts under water and is also soluble in water.—*Chemical News.*

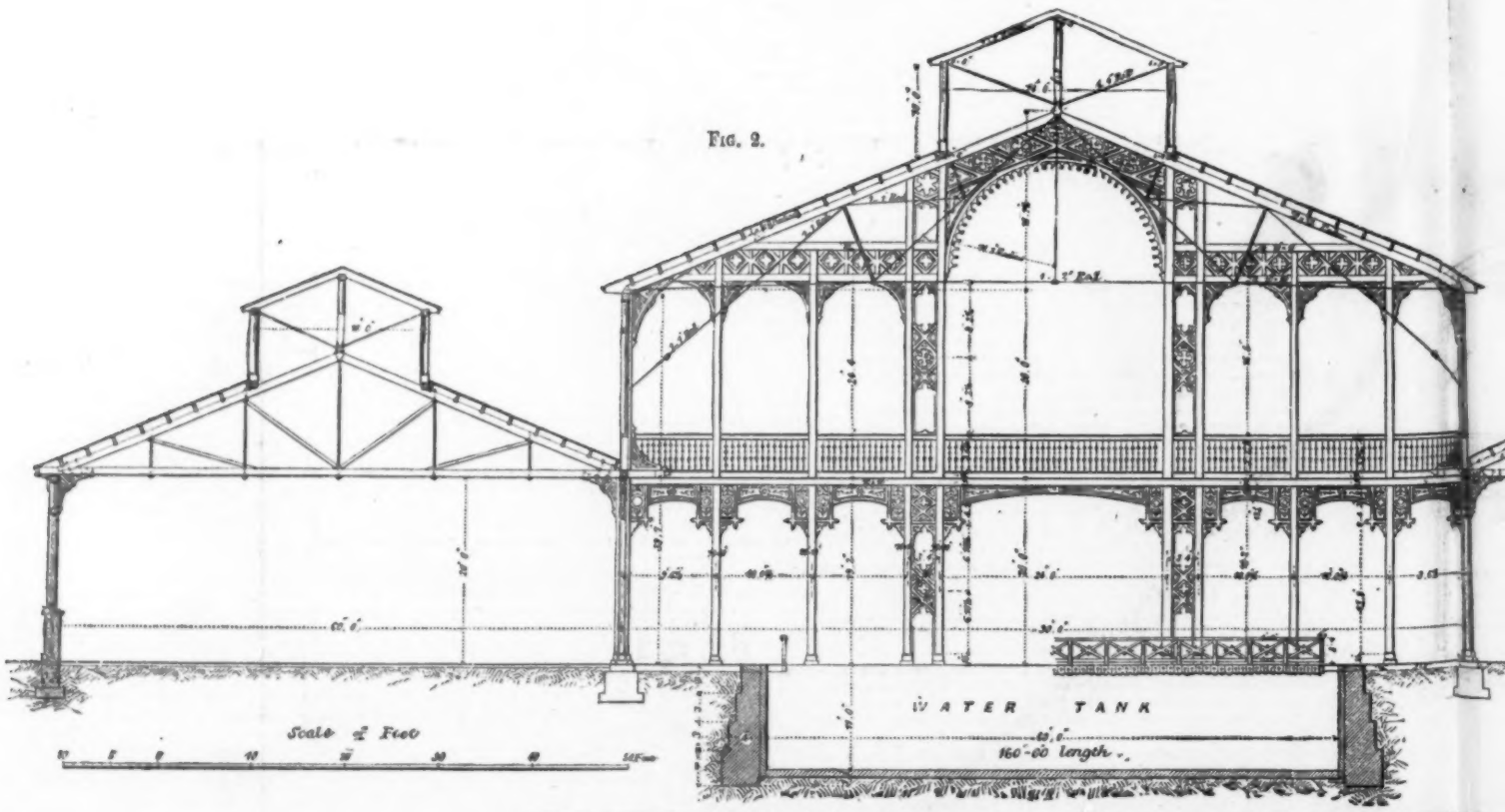
CHIMNEY STRAIGHTENING.

THE lofty chimney-stack at Messrs. Peter Mathews & Son's chemical works, at Pitchcombe, Gloucestershire, has lately become very much out of perpendicular, but almost without any building or engineering works being carried out. the stack has been brought back to its original position., The stack is 132 ft. high, and was built in 1862 by Mrl Gideon Morris. It had gradually fallen from its upright position, and Mr. Augustus Mathews consulted Mr. H. J. Taylor, electric engineer, of Nailsworth, who tested its position, and found it to be 3 ft. 10 in. out of perpendicular, but undertook to restore it to its original position by a process requiring no scaffolding. The terms were agreed upon, and accordingly Mr. Taylor commenced operations a few weeks ago, assisted by three workmen. The chimney is of an octagonal shape, and the operations of Mr. Taylor consisted in cutting out one course of bricks from five of the sides, and inserting a thinner course, and then letting the chimney fall upon the latter and so pull itself upright. For this purpose he erected a platform about forty feet from the base, and with hammers and chisels he and his men cut through the chimney, which at this point was of the thickness of about two feet. As the bricks were removed from each side, a thinner course was substituted, and the intervening spaces were filled with iron wedges. This work lasted for about three weeks, and unfortunately the weather was most unfavorable, being frequently very boisterous, and naturally causing considerable alarm both to Mr. Mathews and to the venturesome engineer himself. However, the chimney stood through it all, and when every thing was in readiness the wedges were withdrawn by Mr. Taylor and his three men, and the stack was brought within a inch or two of its perpendicular position. The finishing stroke was performed on the evening of the 5th inst. It required nice calculation to carry out this work, and Mr. Taylor is complimented on the exactness with which he did it. He estimated that a quarter of an inch would bring over the stack about seven inches at the top, so that he had to let it down about an inch and a half, and had he exceeded his calculation by one-eighth of an inch, the stack would have been brought too far over, and there is little doubt that it would have completely collapsed, and killed those on the spot who were removing the wedges, as the weight above where the work was being carried on was estimated at 150 tons. The erection of a new stack would probably cost something like eight hundred pounds, whereas this has been straightened at about a tenth of the cost, and is now stated to be in as good a condition as a new one.—*The Building News.*



THE INTERNATIONAL EXHIBITION OF 1876.—SECTION OF THE

Fig. 2.



THE INTERNATIONAL EXHIBITION OF 1876.—TRANSVERSE SECTION O

THE INTERNATIONAL EXHIBITION OF 1876.

CONTINUING the series of illustrations showing the general designs and detailed constructions of the buildings composing the International Exhibition, we publish this week a two-page engraving, on which Fig. 1 represents a transverse section through the Main Exhibition Building at the towers, and Fig. 2 a transverse section of part of the building forming an annexe to the machinery hall. We are indebted for these engravings and particulars to *Engineering*. This building is situated on the south side of the machinery hall, the centre lines of the two structures coinciding, and the two being connected by a short passage 90 ft. wide. This passage is the same width as the central transept of the machinery hall, and a roof of the same span, flanked on either side by aisles 60 ft. wide, compose the annexe, which is thus 210 ft. wide, while the length is 208 ft. In the centre of the smaller building is placed a large tank, 160 ft. long, 60 ft. wide, and 10 ft. in depth, the special object of the annexe being for the exhibition of hydraulic machinery in operation. At the south end of the annexe there will be a fall of water 35 ft. high and 40 ft. wide, supplied by pumps, which will form a part of the exhibits.

The Ho
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Gallery,
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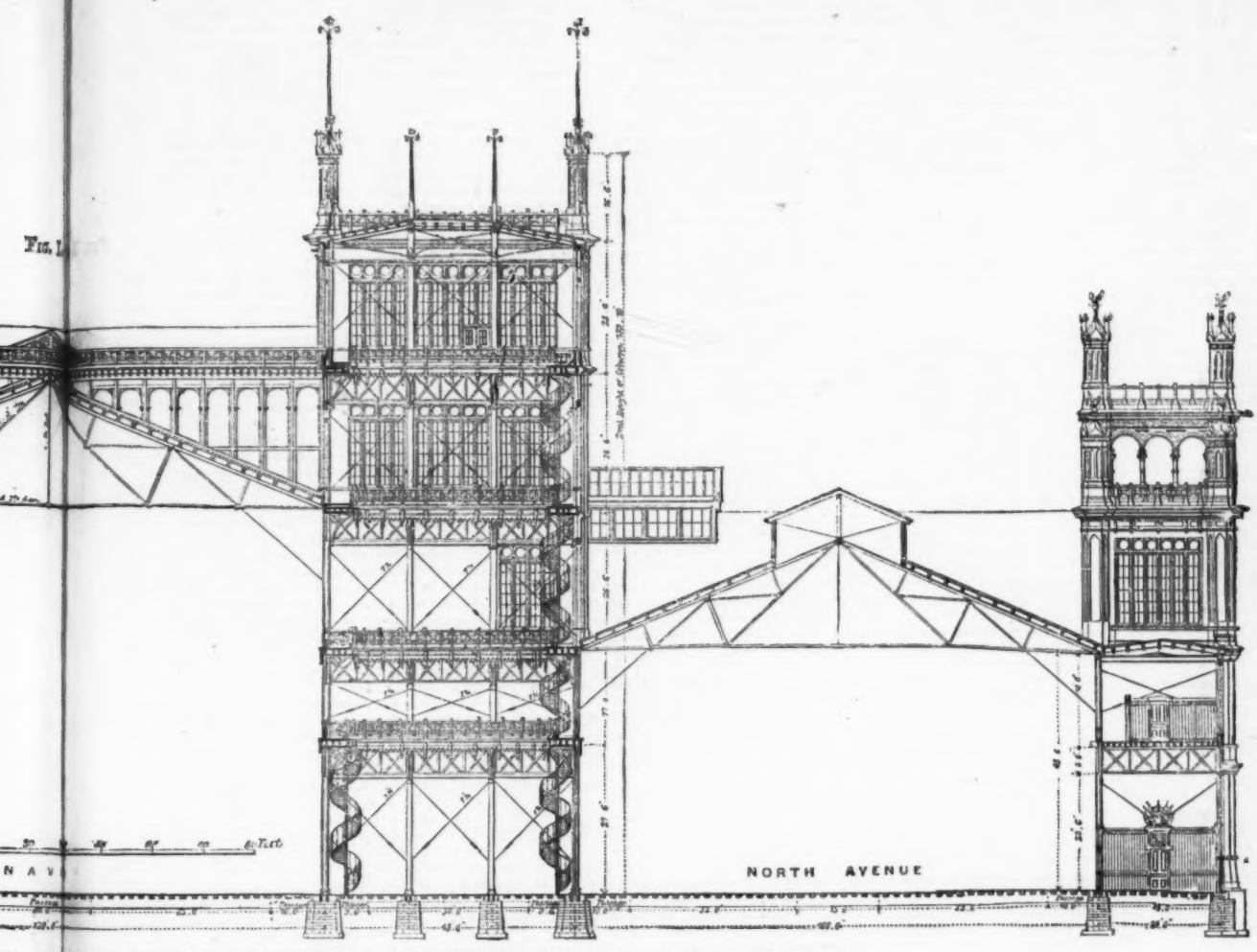
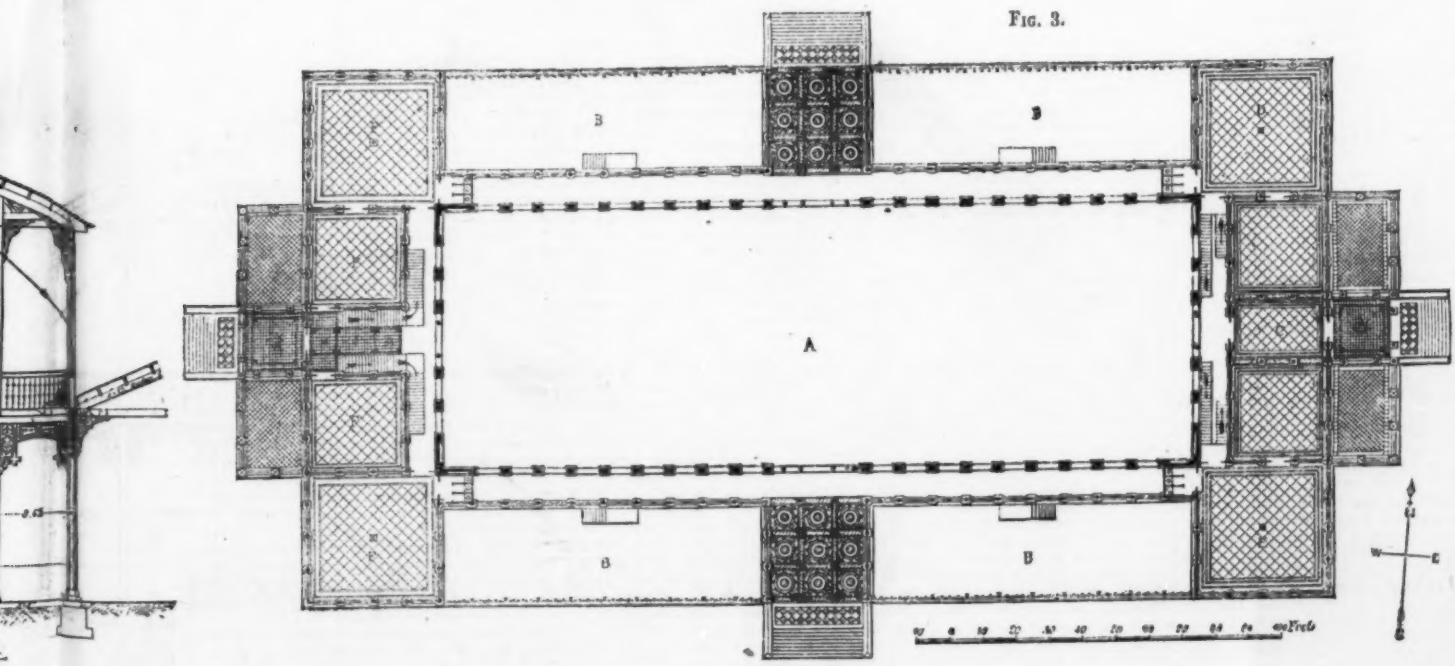


N OF THE MAIN BUILDING AT THE TOWERS, WITH ANNEXE.

FIG. 3.



ECTION OF THE ANNEXE.—PLAN OF THE HORTICULTURAL HALL.

The Horticultural Hall will be a structure of no small pretensions. It lies to the north of the main building and Art Gallery, commanding the same view as the latter. The length of the building is 383 ft., the width 193 ft., and the extreme height is 72 ft. The elevation of this building we publish on page 37, and Fig. 3 is a plan which shows the general arrangement adopted. The leading feature is the central conservatory, 230 ft. by 80 ft. by 55 ft. high, surmounted by a lantern 170 ft. long. At a height of 20 ft. from the floor, a gallery 5 ft. wide runs entirely around this conservatory. At each end of the structure are two hothouses, each 100 ft. by 30 ft., and between them are vestibules 30 ft. square. In the middle of the east and west fronts are other entrances, and on either side are restaurants and offices. Stairways lead to the inner galleries before mentioned, as well as to the outside balconies placed over the roofs of the hothouses, and each 100 ft. long and 10 ft. wide. The arrangements for heating the stoves, etc., are placed in the basement of the building.

In addition to the elevation of the Horticultural Hall, we also give on page 37 an elevation of the Main Exhibition Building. We shall have occasion to refer to these engravings in future numbers.

[The London Times.]

THE CUNARD FLEET.

THIRTY-SIX years ago—a time so short that a man scarcely past middle age can remember it as if it were yesterday, although so long if we measure it by the material progress which it has witnessed—the mails between England and Halifax, Nova Scotia, were conveyed in sailing vessels, Government ten-gun brigs, which, in the naval parlance of the day, were commonly known as "coffins." The possibility of steam navigation had been demonstrated about twelve or fourteen years earlier, and coasting steamers were then actually engaged in trade. Between Glasgow and Liverpool there were two keenly competing lines of such steamers, one of them represented by the Messrs. Burns, of Glasgow, the other by the Messrs. MacIver, of Liverpool. Thoughtful men had already begun to foresee that this steam coasting trade would probably in time be extended to the ocean, and the British Government had pledged itself to use the first opportunity of so extending it by the substitution of steam mail-packets for the vessels then in use. Mr, afterwards Sir Samuel, Cunard, of Halifax, threw himself heartily into the proposed enterprise, came to England for the purpose of promoting it, and accepted the Government tender for the carriage of mails across the Atlantic. Mr. Robert Napier, of Glasgow, the eminent marine engineer, introduced Mr. Cunard to the Messrs. Burns and the Messrs. MacIver, and these gentlemen joined with him to constitute the co-partnership which has since been known as the Cunard Company, and which undertook to carry the wishes of the Government into effect.

In pursuance of this undertaking, the new company entered into a contract for the fortnightly conveyance of mails between Liverpool and Halifax, Boston and Quebec. The contract was for a term of seven years, and the ships employed under it were to be of such a build that they might be available as troop-ships or for transporting stores in time of war. Four steamers were at once commenced—the Britannia, the Acadia, the Caledonia, and the Columbia, each of 1200 tons gross register, and of 440 horse-power. The first of these, the Britannia, left Liverpool on her first voyage on the 4th of July, 1840, and entered Boston Harbor after a run of fourteen days and eight hours.

Even to those who watched her as she was receding from the shores of England, the departure of the first Atlantic steamer was an event of no small significance; but her rapid passage and safe arrival at Boston were there hailed with an enthusiasm which sprang from a quick and just appreciation of the benefits which would follow in her wake. At that time the American people, although they were beginning to realize the boundless resources and the gigantic future of their country, were, nevertheless, fully conscious of their comparative isolation from the arts and sciences and commerce of the Old World. The Britannia was like a hand stretched out from England to invite America to assume her proper place in the comity of nations; and her voyage not only was, but was felt to be the harbinger of that prodigious growth of intercourse, and that prodigious rapidity of communication which are among the greatest marvels of our own age. The good ship came to her moorings late on a Saturday evening, but the inhabitants of Boston thronged the wharves to welcome her, and fired salutes of artillery in honor of her arrival. Three days afterwards, on the 23d of July, Mr. Josiah Quincey, Jr., presided at a public banquet held in celebration of the establishment of steam postal communication between Great Britain and America, and it is recorded that Mr. Cunard, who had himself accompanied this first great venture of his firm, received eighteen hundred invitations to dinner during the first twenty-four hours of his stay in Boston.

For seven years, the four steamers already mentioned, reinforced by two others of increased dimensions and power—the Hibernia and the Cambria, each of 1423 tons—were sufficient for the fulfilment of the mail contracts, and for the demands of the increasing traffic both in passengers and cargo. At the expiration of this time, the British Government, realizing the increasing importance of the mail service, called upon the Company to double the number of its sailings. The change rendered it necessary to double the fleet, and four new vessels—the America, the Canada, the Niagara, and the Europa—were added early in 1848. These ranged from 1800 to 1900 tons burden, and from 600 to 700 horse-power, and they were followed in 1850 by the Asia and the Africa, each of 2227 tons, and of 750 horse-power. These again were followed by two others, one of which was sold to the West-India Company, the other being the Arabia, which rendered good service during the Crimean War. She was of 2400 tons burden and 285 feet long, this being the greatest length upon which it was thought desirable to venture in a wooden vessel with a view to strength and endurance in the Atlantic. Every new steamer was in some respect an improvement upon its predecessors—generally in point of size and capacity, always in point of comfort and accommodation.

Prior to 1852, the fleet of the Cunard Company had consisted entirely of wooden vessels propelled by paddle-wheels, but in that year the Andes and Alps, both iron vessels with screws, were added to the long "catalogue of the ships." These were afterwards taken up by the British Government for transport service to the Crimea, and they were followed, in 1854 and 1855, by the Jura and the Ætna, both iron screws, and both for the Atlantic trade. In 1856, with the Persia, the experiment was tried of building an iron paddle-steamer. The Persia was of 3300 tons burden, and 900 horse-power, and she was followed, in 1862, by the Scotia, also built of iron, and of still larger dimensions. It soon became apparent not only that iron was the best material for ocean steamers, but also that the screw furnished the best means of propelling them, and in all the subsequent additions to the fleet these truths have been recognized and acted upon.

While no effort has been spared to render the Atlantic steamers fitting channels of communication between two great nations, the operations of the Cunard Company have not been confined to this single branch of traffic. The Company was formed, as has been said, by the amalgamation of firms engaged in coasting business, and this has been continued with as much energy as the business which has been added to it. Their steamers, which have been under contract for thirty years and more, carrying the mails between Glasgow, Greenock, and Belfast, have performed this service most satisfactorily, and are remarkable for symmetry and speed. Between Glasgow and Belfast, Glasgow and Derry, and Liverpool and Glasgow the steamers of the Company ply regularly, and no fewer than ten are engaged in these services. On the repeal of the Navigation laws, the Cunard Company was the first to commence bringing French goods from Havre in transit for shipment to America and to Mediterranean ports. They have now twenty-seven steamers (including the vessels which carried the mails for thirty years between Halifax, Bermuda, and St. Thomas), which go to Havre and to all the chief Mediterranean ports (as Gibraltar, Malta, Syra, Constantinople and Smyrna), to the Adriatic, and to the Gulfs of Lyons and Genoa. In all these vessels there is accommodation of the first class for passengers, and every facility is given to tourists who desire to go from point to point, and to continue their progress by a different vessel from that in which they originally embarked.

It is not only in the pursuit of peaceful commerce that the Company has been enterprising and successful. It was part of the original mail contract with the British Government that the ships should be available as transports in time of war; and it has already been mentioned that the Andes and Alps were so employed. They were chiefly used in the conveyance of sick and wounded from Balaklava to Scutari, and were by no means the only auxiliaries furnished by the Company. On the 24th of February, 1854, the Niagara sailed with 887 officers and men, and 12 horses, for Malta, in anticipation of the great struggle which was then impending. She had only arrived from Boston on the 13th of the same month, and less than a week was consumed in preparing her for her new duties. On the 14th of the same month the Cambria arrived from New-York, and was immediately fitted up to receive 647 men and 12 horses. She was ready on the 18th, and sailed for Dublin on the 22d to embark her troops. The Jura, the Europa, the Arabia, and the Ætna were all employed in the same manner, and were all prepared with the same alacrity. In 1855 the Arabia was specially required for the transport of horses, and the necessary accommodation for 203 horses was fixed on board of her within 14 days from the receipt of the order. The Emu was bought from the Pacific Company to supplement the fleet, then overtaxed by the exigencies of the Government requirements.

Again, in 1861, when the friendly relations between Great Britain and America were put in jeopardy by the forcible arrest of Messrs. Mason and Slidell when on board the Royal Mail steamer Trent, the resources of the Cunard Company were at once called upon to convey troops and stores to Canada. The arrest was made at the beginning of winter, when time was of exceeding value. On the 4th of December, orders were telegraphed to Liverpool to fit up the Australasian as a transport. She was completed on the 10th, took in her coals on the 11th, embarked the 60th Rifles and stores on the 12th, and sailed for Halifax on the 13th. On the 5th of December similar orders were received with regard to the Persia. She received her coals on the 14th, embarked 1270 officers and men on the 15th, and, under the command of Captain Judkins, landed them at Bic, on the St. Lawrence.

Since 1840, when the Cunard Company, strictly so-called, came into existence, it has built 122 steamers; but the members of the firm, since 1824, have built no fewer than 158, the list commencing in that year with the Fingal, of 206 tons burden, and 100 horse-power. In only two instances during this long period has a passenger sustained any bodily injury; and in each of these, an action for damages having been brought, and having been defended on the ground that the injury was due to the negligence or fault of the sufferer, the verdict of the jury was given in favor of the defendants. This exemption from casualties has sometimes been described as "luck," but only by those who fail to perceive that no person, and no firm, was ever continuously "lucky" for fifty years. It has, in truth, been simply the natural result of a care and foresight which have scarcely left luck an opportunity of intervention, which have dealt equally with the largest questions and the minutest details, which have extended to every particular of construction, equipment, and service, and which, not content with seeing every thing well done in the first instance, have secured the perpetual maintenance of the prescribed standard by incessant watchfulness and supervision. On this point it will be necessary to speak once more when the preparations for the departure of each ship are described.

The Cunard fleet, as at present constituted, consists of 49 vessels, having an aggregate of 90,506 tons of gross tonnage, and 14,457 nominal horse power. Twenty-four vessels are in the Atlantic Mail service, 12 on the Mediterranean and Havre line, five ply between Glasgow and Belfast, three between Liverpool and Glasgow, three between Halifax and Bermuda, and two between Glasgow and Derry. The money value of the Atlantic Mail boats alone has been estimated by a competent authority at between three and four millions sterling; and it would probably not be an exaggeration to state that of the entire fleet at double the amount.

The Bothnia and Scythia, sister ships, and alike in almost every particular, are the largest and the most recently built of the American steamers of the Company. The Bothnia is bark-rigged, and measures 420 ft. in length of keel by 42 ft. 6 in. in breadth of beam. Her deck affords to passengers an unbroken promenade of 425 ft. in length. Her engines are of 600 nominal horse-power, and are on the compound principle. She is fitted with a deck-house to protect her steering-gear, and with a system of signalling by a lever and crank apparatus from the bridge to this house, so that orders can be conveyed instantly to the man at the wheel, and the receipt of these orders can be acknowledged by a return signal. There is also a steam-steering apparatus to be used in case of need, and a system of signals and return signals between the bridge and the engine-room. The vessel is divided into nine water-tight compartments by cast-iron bulkheads, and the openings through these bulkheads, necessary for ordinary traffic, can be instantly closed by cast-iron doors, which are secured by lever-handles acting upon wedges. The accommodation for first-class passengers is of the most luxurious description; the sleeping-cabins are large and airy, the saloons light, spacious, and tastefully decorated. The Bothnia carries ten boats, which are capable of containing her full complement of people, and she has a crew of 150 officers and men all told, divided into the three classes of seamen, engineers and firemen, and stewards. It has always been part of the Cunard Company's system that every man, whatever his duties on board the ship, should be a member of some particular boat's crew, and that the crew of each boat should be formed from all three of the classes which have been mentioned. The crews are only engaged for the single voyage out and home, and, although the same men may ship over and over again, yet every crew is liable to contain men who are new to the service. As soon as all are on board, each man is informed to which boat he is attached, and who is the commanding officer of that boat, and each boat officer is expected to know every member of his boat's crew. In order to prevent mistakes, each man wears a metal badge, with a brooch-fastening, which bears the number of his boat; and, as soon as an order for boat service is given, each man is expected to repair to the boat to which he belongs, and to await further orders. In each boat's crew there are four seamen, each of whom has his own definite duties, so that they know exactly what is required of them, and are not liable to get in each other's way, or to wrangle in times of emergency.

When a vessel is ready to sail, but before the passengers are received on board, a complete inspection is made by her commanding officer, who is always accompanied by one of the Messrs. MacIver, and by the Marine Superintendent, Captain Inglis. The crew are drawn up for inspection in two lines, on the starboard and port sides of the deck, each man wearing the badge of his boat, and ready to answer to his name. The muster-roll having been called, orders are given to prepare for boat service; and the men break up into the necessary number of crews, each at his own station. Each boat's crew is first called over, the four seamen answering to their names by saying "number one," "number two," "number three," and "number four;" but the engineers and stewards answer "here" only. When this is done the order "boats out" is given. The boats are covered by proper tarpaulins, under which they each contain such necessaries as a keg of water, oars, spars, sails, and axe, and other appliances. Each boat's crew works independently of the rest, but a certain emulation to be first stimulates them all, and in the case of the Bothnia three minutes suffice to have her ten boats in the water, while the captain, from his place of vantage on the bridge, looks sharply after laziness or awkwardness. When the boats are down, and proof has been given that every thing connected with them is ready for service, the order to haul them in is given, and in a few more minutes they are restored to their customary resting-places. The same organization of crews is applied to fire duty; and as soon as the boat inspection is completed a fire-drill takes its place. In this some men have charge of buckets, with ropes attached to them, so that they can be filled over the side and hauled in. Others have to fetch and join the hose, to connect it with pumps worked by the engines, or to take charge of the jets. Others are prepared with blankets, to be wetted and thrown over the flames, but the essential matter is that every man has his place and his duty, and every man is acquainted with them both. The same division into crews, as for the boats, is also used for manning the pumps, and as soon as the fire-drill is over, the pumps receive the next attention. Each crew is expected to be in its place, each pump is tested and examined, and it is shown that there is now water in the bilge. This done, the crews are dismissed, but the inspecting party proceeds to make a complete tour of the vessel. The store-rooms are visited, and the steward is cautioned with regard to his duties in respect of them, and is especially told that no other light than that of a closed and locked lamp must ever be taken to them. Every water-tight door is shut and tested to see that it moves freely on its hinges, and that none of its lever fastenings are rusted or out of order. The supply of rockets and other signals is examined, the steering and signalling apparatus tried; and only after every thing has been found to be in order is the word given for the ship to embark her passengers and to proceed upon her course. In addition to all this care, every officer is responsible for the condition of things in his own department, and the captain for all, so that the smallest imperfection would be reported as soon as it was discovered, and rectified as soon as rectification was possible. The Cunard Company does insure, but yet takes its own risks to a certain extent, and no known risks are ever incurred. If the smallest defect is discovered in any part of a ship, no question is raised whether it will bear one voyage or two voyages more, but the order "Out with it" is given at once. A passenger on board a Cunard steamer may always feel certain that every thing in the ship was inspected by responsible people before the voyage was begun; that nothing is jammed or rusty or out of gear, but that every thing is clean, and ready to work smoothly and easily in its place. The reign of order on such a vessel is well nigh as absolute and as complete as on board an English man-of-war.

Among the many precautions regularly taken by the Company, it may be mentioned that, on account of the danger of navigating the Mersey by insufficient light, the ships are never allowed to leave Liverpool in the afternoon or evening. They always sail in the morning; and in consequence of the state of the tide, this often necessitates a very early departure. The ships of the Cunard Company have all been built in the Clyde, chiefly by the Messrs. Napier, and of late years by Messrs. J. & G. Thompson and others. The builders have no responsibility beyond that of following the plans and specifications which are delivered to them by the Company, and in which the most minute points of detail are provided for with a care and knowledge which are the results of more than forty years of an experience unequalled in its extent and its variety, and unsurpassed in the liberality by which it has been guided, and in the wisdom with which its teachings have been applied.

A fleet thus numerous, thus built, thus manned, governed, and provided must, it is manifest, furnish the means of subsistence to an enormous number of people. It has already been said that (in the Ocean Line) the crews are engaged only for a single voyage out and home, and a single sailor may thus be engaged as many as five times in the year, and may be counted five times over. After this preface, the first thing to be mentioned is that the Company shipped and discharged 43,000 men during the year ending on the 1st of July, 1872, so that they may be said to have given constant employment afloat to at least 8600 persons, the great majority of whom would be the bread-winners of families residing in Liverpool, or its vicinity; and the figures of this single year fairly represent the ordinary course of their operations. Besides the crews, about 1500 men find regular employment in the work of loading and unloading the ships; and from 500 to 1500 more are engaged at the docks of the Company in Liverpool in fitting and refitting vessels to meet the demands of different kinds of service, and in repairs. Hence the Company, although a private enterprise in the hands of only three families, is entitled to rank with the great railway and other public companies as an employer of labor, and the proprietors have always been ready to recognize the responsibilities which attach to such a position, not only by promoting schools, asylums, and other provident or charitable institutions for the benefit of seamen of the port of Liverpool, and of those dependent upon them, but also by public services on various occasions. In 1871 they enrolled a regiment of Volunteer Artillery (the 11th Lancashire), about 500-strong, composed entirely of their own employees, and maintained it, under the command of Mr. MacIver as Lieutenant-Colonel, until 1867, when it was disbanded on account of a proposal to mobilize Volunteer regiments—a proposal which, if it had been carried into effect, would have deprived the Company of men whom they could not spare. In 1867, when troops were ordered to Liverpool on account of the Fenian disturbances, the same public spirit was displayed. Chief Constable Major Greig, in his "Letters and Recollections of '67," says: "The utmost difficulty was felt because of the want of accommodation for the troops ordered here. This, in a moment, was met by Colonel MacIver munificently placing at the disposal of the authorities, not only his large drill-shed, but also two of the Cunard mail steamers. The troops occupied them upwards of a month, and no charge was made either to the Corporation or the Government."

The ships thus employed were the Australasian and the

Africa, and the troops accommodated were about 1200 strong. For this service, Mr. MacIver received the thanks of the Commander-in-Chief, and also a special resolution of thanks from the Corporation of Liverpool.

In the year 1874 the ocean-vessels of the Atlantic fleet made 123 trips from Liverpool to New-York and Boston, and the same number in the opposite direction. The outward-bound steamers carried 9198 cabin passengers and 26,570 steerage passengers (mostly emigrants) from England to America. The homeward-bound steamers brought 7933 cabin passengers and no steerage passengers from America to England. In a single year, therefore, the company conveyed nearly 44,000 persons across the Atlantic. If the crews were included, the total would be about 80,000; and even this number has been exceeded in other years. Not only were all these people conveyed, but they were all conveyed in safety. It is now many years since the increasing traffic directed the attention of the company to the risks that would be run if all vessels, both outward and homeward, were crowding along the most direct sailing track, a course which would render the occurrence of collisions a mere question of time. In order to avoid this danger, the Company determined to lay down sailing lines which should not only keep the outward and the homeward bound vessels apart, but which should also keep both classes somewhat away from the ordinary highways of Atlantic navigation. The outward-bound steamers, from Queenstown to New-York or Boston, cross the meridian of 50 deg. at 43 deg. latitude, or nothing to the north of 43 deg., while on the homeward passage they cross the same meridian at 42 deg. latitude, or nothing to the north of 42 deg. Like express-trains, they may be said to run upon their own up and down lines, and to follow each other at intervals which are sufficient to insure safety.

Besides passengers, the great fleet conveys every year countless tons of merchandise, composed of articles infinite in number and in variety. The exports consist chiefly of iron, machinery, yarn, soda, fine goods from Manchester, French silks, and *articles de Paris*. The imports consist largely of cotton, cheese, grain, and leather, and the best notion of the magnitude of the transactions of the Company may be gathered from the sums which they pay in tonnage dues, and from the proportion borne by these sums to the whole tonnage of the port of Liverpool. Taking eight years, from July 1866 to July 1874, and quoting from official returns, it appears that during this time the Company paid no less than £189,351 in tonnage dues, or an average of £23,668 a year. In the same period the total tonnage dues of the port were, for steam and sailing vessels together, £2,409,304, and for steamers alone, £1,226,045. It follows that the Cunard Company pay about 1-13th of the total tonnage dues, and about 1-7th of the steam tonnage, of the port of Liverpool.

THE SEWERAGE OF BRIGHTON.

AT the fifth meeting of the session of the Institution of Civil Engineers, held on Tuesday evening, the 7th of December, Mr. Thomas E. Harrison, the President, in the chair, the paper read was on "The Brighton Intercepting and Outfall Sewers," by Mr. J. G. Gamble, B.A., Assoc. Inst. C. E.

The paper stated that the area affected by these works was about 1800 acres, and comprised the whole of what was ordinarily called Brighton. Portions also of the parish of Rottingdean, east of Brighton, might be drained into the intercepting sewer. The range of tide varied from 23 ft. to 9 ft. The geological formations were the "upper chalk," or "chalk with flints," with overlying strata westward, and in the valleys, chiefly of fine sand. Towards the west end of Brighton a stratum of clay was found near the surface.

Until about thirty years ago, the sewage of Brighton was drained into cesspools. Such sewers as there were chiefly served to convey away rain-water to the upper part of the beach. When, however, the houses were drained into the sewers, the sewers became a great nuisance, and were gradually extended further and further seaward. In 1870, at the time of passing of the Act for the present works, there were eight outfalls, all of which, with one exception, were abolished, the sewage passing to the outfall at Portobello.

To remedy the evil, Mr. Hawksley, Past-President Inst. C.E., proposed still further to lengthen the pipes. Mr. Robert Rawlinson, C. B., M. Inst. C. E., suggested an intercepting sewer, with an outfall to the westward of the town. Sir Joseph Bazalgette, C.B., M. Inst. C.E., recommended an intercepting sewer, with an outfall to the eastward, near Roedean Gate. Messrs. Maclean and Wright also proposed that the sewage should be taken in the same direction, but placed the outfall at Saltdean. The present position, Portobello, was recommended by Sir John Hawkshaw, Past-President Inst. C. E., who designed and carried out the whole of the work, the author being the resident engineer. Mr. Matthew Jennings originally took the contract for the works, but they were finished by Messrs. John Aird & Sons.

The intercepting sewer began at Hove street, ran under the Shoreham road nearly to the end of Brunswick-square Lawns, passed under the beach till it entered again under the road at East street, and excepting for a short distance at Rottingdean, it extended from thence under the Marine Parade and the Newhaven road to Portobello. The sewer was of brickwork, and was of a circular section, 5 ft. in diameter, up to East street; 6 ft. in diameter between East street and the Steyne; 7 ft. in diameter from the Steyne to the Penstock Chamber, Portobello; and between the Penstock Chamber and the sea, the sewer was partly of brickwork, partly of three cast-iron pipes, 4 ft. in diameter, laid side by side; the total distance was 38,590 ft., or 7¼ miles. The average fall was about 3 ft. in the mile.

	Above Low Water of Spring Tides. ft.	in.
The invert at Hove street was	21	6
" the Steyne	15	3
" Blackrock	14	3
" the Penstock Chamber	2	0
" the outfall	0	0

Besides the main line a considerable length of junction sewers was constructed to connect the old main sewer by suitable curves. Catch-tanks were inserted in the tributary sewers just before their junction with the main sewer. These catch-tanks were of different dimensions, according to the quantity of material expected. The tank at the Steyne was 40 ft. long and 18 ft. broad. The deposit was almost entirely road-drift, and as it mainly came in after storms, it was very little contaminated by sewage. All these tanks, as well as the bell-mouth chambers, were ventilated by shafts to the road. There were twenty-four side-entrances, including the Penstock Chamber. Besides these, nine of the ventilators had hand and foot irons built into them; four of these had entrances from the beach, as well as winding staircases to the road. When the entrance was double, the main shaft was generally used as a working shaft during progress—the passage to the beach, the manhole on the footway, and the ventilating passage communicating with a grate in the centre of the road. Besides the thirty-three entrance shafts, there were twenty-eight smaller shafts, only intended for ventilation. Where the sewer was under the roadway, the gratings were not directly over the sewer, but a small pit was interposed to catch pebbles and dirt. The grates were of cast-iron in two parts. The interior portion could be lifted out without disturbing the outer one or the road metalling. The circular shafts were connected to the springing of the sewer by walls battering inwards, and starting from the springing of the sewer. When the surface was at a considerable height above the sewer, the ventilators at the lower end of the sewer had irons let into the walls to enable the flushers to get out. Where very deep they had in addition a special recess, considerably above the level of the storm overflows, as a refuge for flushers.

There were three storm overflows in Brighton, at the former western, central, and eastern outfalls, respectively. In the six months ending the 21st of December, 1874, the central overflow had come into operation three times, and the other two once. In the first six months of 1875 the storm overflow only came into operation once. In that at the Steyne a weir was built in a slanting direction across the old sewer, and the ordinary drainage passed along a new sewer towards its junction with the intercepting sewer. The level of the top of this weir was about 2 in. higher than the old storm overflow, a level found sufficient to prevent the flooding of the lowest basements in case of the water getting past the house-drain flaps, and backing-up the house-drains. The storm water was discharged by the former central outfall. An inlet had been constructed at the Steyne with penstocks to admit sea-water to flush the lower part of the sewer; this was generally used at spring tides. Arrangements had also been made for working two sets of penstocks, one by which the tide should be shut out in case of the valves not acting, the other for penning back the sewage temporarily, so as to flush the outfall at low water. This chamber was provided with a passage to the beach, and with a louvred roof for ventilation. Between the penstock and the sea, the section of the sewer changed from a circle to a semicircular arch with a flat invert, and then again, by an arched chamber, to three iron pipes. The iron pipes were held together in a frame of greenheart timber, with wrought-iron bolts, and the pipes were retained in line by bolts which passed through lugs cast on them for that purpose. Beyond the mouth of the pipes the sewage ran in a trench only visible at low water during spring tides.

The progress of the work and the method of laying out the line of sewer were next described. The works were begun in January, 1871, and were completed in June, 1874. Between Hove street and the Steyne, a length of two miles, the sewer was built in an open cutting, while between the Steyne and Portobello, a length of over five miles, it was tunnelled through chalk. The brickwork was 9 in. thick, except between Rottingdean and the Penstock Chamber, where it was 13½ in. thick, and between the Penstock Chamber and the sea it was 18 in. All this brickwork was set in Portland cement mortar with the exception of the walls of the Penstock Chamber, which were in greystone lime mortar. Gault pressed bricks, or bricks made at St. John's Common, near Burgess-hill, were used in the inverts; and ordinary Gault or stock bricks in the arches. The bricklayers were paid 10s. for each 12 ft. length of 9 in. work, and 15s. for each 12 ft. length of 13½ in. work. Brick blocks of eight whole bricks and four and a half bricks were used when the bottoms were wet. Radial bricks were not required, owing to the large diameter of the sewers. More than six million bricks were used—sixty-three courses being required in the inner ring of the 5 ft. sewer, and eighty-six courses in the 400 lineal feet of brickwork in tunnelling were executed per 7 ft. sewer. Pipes were laid under the invert to carry off the water—much of which was met with while the brickwork was being put in. When the junction was made between the brickwork from one shaft with that from the next, the pipes were plugged or closed by a valve built for that purpose. Under the sills at Portobello iron pipes were used, which were afterwards filled with Portland cement grout. So great was the pumping that the wells at Rottingdean and at the Coastguard Station at Portobello were seriously affected. For a considerable period 15,000,000 gallons of water were pumped every twenty-four hours, the water in most cases being raised about 30 ft. At this time thirteen pumps about 20 in. in diameter were employed, worked by one 50 horse-power stationary engine, and eight portable engines averaging 14 horse-power each. The water gave considerable trouble in setting the brickwork.

The ventilation of the sewer during the progress of the works was good in every portion where there were two openings. Where there was only one opening the air in the heading became bad, and openings to the cliff had frequently to be made.

The total cost of the work had been about 100,000*l*. The cost of a lineal foot of the 5 ft. sewer, which was built almost entirely under the first contract and in open cutting, was 29s. The cost per lineal foot of the 7 ft. sewer, 9 in. work, which was done by tunnelling, was 27s. under the first contract, 41s. under the second. The extra cost of three-ring work (13½ in.) over two-ring work (9 in.) was, under the first contract 12s., under the second 16s. per lineal foot. The cost of a ventilator varied from 20*l*. where the sewer, as at Cliftonville, was not far from the surface, to 160*l*., where the ground level was, as at some places on the Newhaven-road, from 150 ft. to 160 ft. above the invert. The staff now employed under the Brighton town surveyor on these works was one inspector and six flushers, including two men at Portobello to take care of the penstocks.

MEDICAL.

CELLARS AND DIPHTHERIA.

TOPOGRAPHICAL OBSERVATIONS OF TWENTY RESIDENCE SITES, IMPARTIALLY SELECTED, IN WHICH DIPHTHERIA HAS OCCURRED, IN THE CITY OF DES MOINES, DURING THE SUMMER OF 1875.

By A. G. FIELD, M.D., Des Moines, Iowa.

IN nine residences, with thirty-eight inmates, an alluvium overlying sand and gravel, with dry cellars beneath, and insufficient side ventilation, there were twenty-two cases and four deaths.

In two residences, with fourteen inmates, on alluvium overlying sand and gravel, with wet cellars and insufficient side ventilation, there were four cases, but no deaths.

Five residences, with twenty-six inmates, on alluvium, clay subsoil, damp cellars, with insufficient side ventilation, there were fourteen cases, and three deaths.

Two residences, with fourteen inmates, on filled ground over alluvium, clay subsoil, wet cellars, with insufficient side ventilation, there were nine cases, and four deaths.

Two residences, ten inmates, on low ground, damp cellar, in alluvium with insufficient side ventilation, there were four cases; no deaths.

A window, or an outside door on the south or west only, from which directions come the prevailing winds, as well as openings through basement walls less in the aggregate than one square inch for one square foot of area, are deemed insufficient for ventilation; and more especially so where a door opening through the floor into the cellar has been in daily use. In four instances there was no outside opening whatever. These observations were made, not with a view to sustaining some preconceived opinion or favorite theory, but to arrive at, as far as possible, some of the peculiar conditions under which diphtheria has originated.

The classified grouping shows a cellar or ground excavation under all of the residences where the disease has occurred, and that the greatest fatality has been where the natural surface, previously buried beneath filled earth, has been excavated, thus exposing a zone of great porosity between the original surface and filled earth. The fair inference would be, that with the natural surface was buried also more or less of organic matter, the volatile products of the decomposition of which would thus find an easy outlet; and, therefore, there has been the greatest fatality where the circumstances have been most favorable for the escape of the largest amount of ground air. The lines of greatest porosity in the earth's substance lie more or less parallel to the surface, favoring lateral currents, and this fact applies more especially to these drift formations; and wells, cellars, and shafts afford the most easy escape for ground air, containing as it does a large per cent of carbon, nitrogen, and other products of the decomposition of organic substances. But that ground air does escape through the more compact surface when no excavation offers, is beyond question; and it is only necessary that a dwelling be exposed to the confined air beneath it, to subject its inmates to the deleterious consequences of such poison, if it is not the pabulum and natural habitat also of noxious living organisms.

Another condition presented in the grouping is moisture. It is not certain that a dry cellar in so porous stratum as sand and gravel is, gives forth less water vapor than one in clay containing water does, although the latter certainly affords less ground air, and it is pretty safe to assume that in cellar air in general is an excess of water vapor. This of itself, within a certain limit, is not harmful, and some virtue even is attributed to it as employed in the celebrated *Spas* of Europe, and by residence upon the seashore. But the air of the sea-breeze, triturated in adverse currents, and even that of the prairie winds with often traces of ozone also, is comparatively free from organic impurities. That a moist atmosphere in the ordinary course of natural events may so modify or develop the elements of organic matter as to become accessory to, or productive of, zymotic poisoning, three conditions of it are essential: 1st. A temperature above 50° F. 2d. A state of comparative quiescence or stagnation. 3d. The presence of the products of organic decomposition. All of these conditions are present in a very large majority of unventilated cellars, as well as beneath houses without cellars, where atmospheric air does not have free access.

Here another fact that has happened to come under observation may justify a digression. For the year ending Sept. 1st, 1875, seventy-three (73) per cent of the interments in Potter's Field, as is shown by the register of the sexton, were of children five years of age and under (who were, consequently, mostly confined to house air); while in the cemetery proper only fifty per cent of those interred during the same time were five years old and under. And in Potter's Field the average age of those buried during the same period is ten years, while in the cemetery proper it is twenty years. When these facts are associated with the further facts, that seven-eighths of those whose dead are buried in Potter's Field live upon the low grounds or sandy flats that constitute the point above the confluence of the Des Moines and Raccoon Rivers, and extend also east of the former and south of the latter; while a large majority of the better-to-do citizens reside upon the higher bluffs that on every hand surround the business portion of the city, they have an unmistakable significance. In these sandy flats that are the older portion of the city, stables, cellars, privy-vaults and wells have, for many years, been interspersed with nothing that approximates or deserves the name of sewer to mitigate the consequences.

But to return to the subject proper of this paper; the following deductions may be drawn from the observations:

That all ground exposures of cellars should be cemented. Floors over them should be tight, and inside doors never allowed.

That cellars constructed with a fireplace in them, with an adequate chimney extending to the top of the building, to be used for ventilation, may remove to a large extent the evils arising from sub-dwelling basements and cellars.

That in all instances where such ventilation is not provided, side openings in all of the cellar walls should be in constant use, such openings to be not less on each side than one square inch for every square foot of corresponding side and area.—*Medical Record, No.* 266.

ON THE ACTION OF SULPHOCYANIDES ON PALLADIUM CHLORIDE AND NITRATE.

By SERGIUS KERN, St. Petersburg.

PALLADIUM chloride is used sometimes as a reagent for the detection of iodine, giving palladium iodide (PdI_2) a black precipitate insoluble in water; this reaction is a very delicate one. Studying the action of alkaline sulphocyanides on some metallic compounds of the platinum group, I observed that by mixing aqueous solutions of palladium chloride and potassium or ammonium sulphocyanide a soluble palladium sulphocyanide is formed; the liquor, meanwhile, from a reddish-brown color turns red.

The resulting sulphocyanide of palladium is a very stable compound, in which the presence of the palladium is not easily detected. Thus an alcoholic solution of iodine gives no black precipitate of palladium iodide. Palladium nitrate [$Pd(NO_3)_2$] with potassium sulphocyanide also yields palladium sulphocyanide.

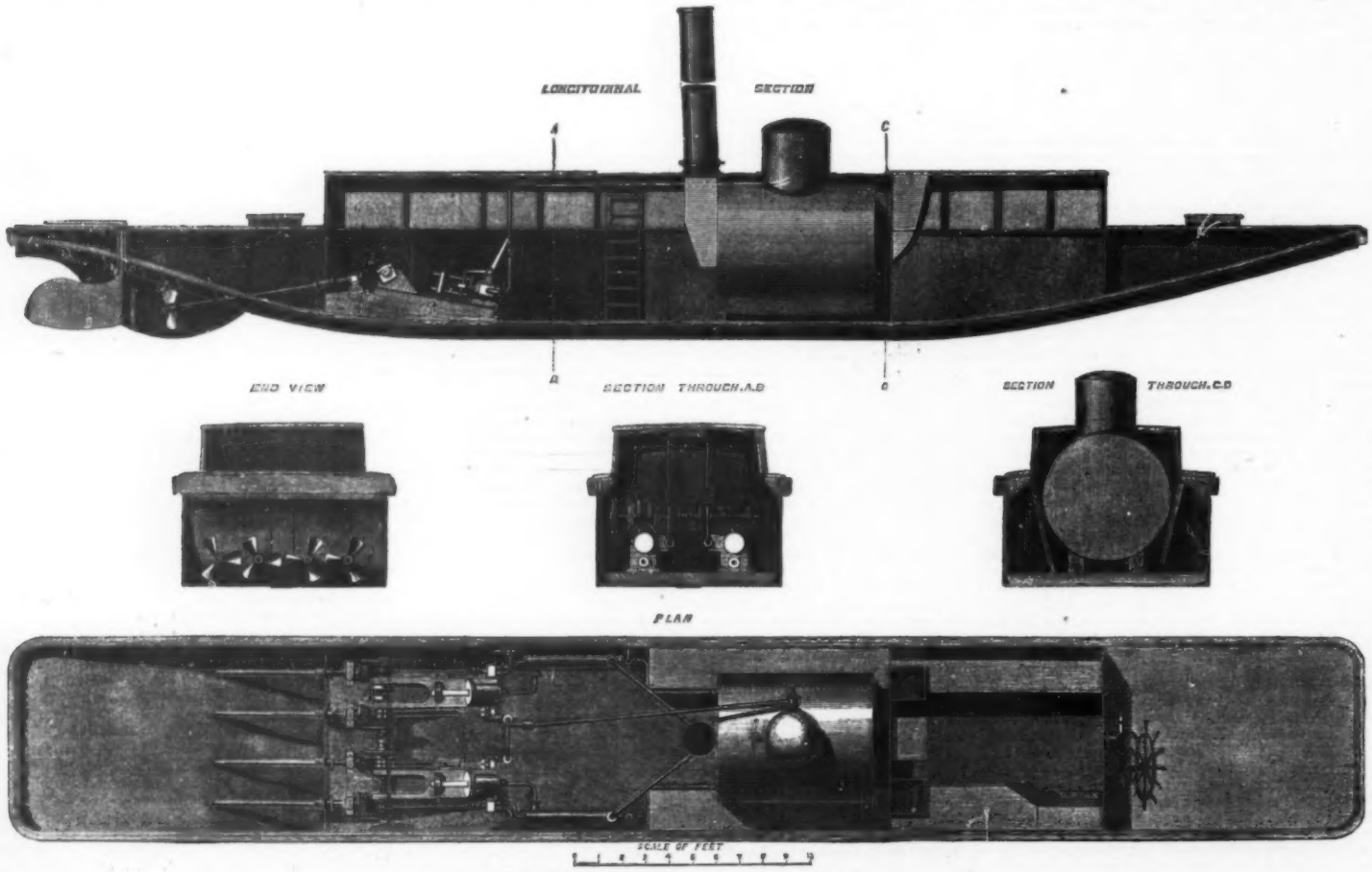
Palladium chloride being often used in qualitative analysis for the detection of iodine, and palladium nitrate for the separation of iodine from chlorine and bromine, it is easily understood from this small research that the presence of sulphocyanides in the analyzed liquors must be avoided, because if they are present faulty results may be obtained.—*Chemical News.*

NEW STEAM CANAL TUG.

THIS improved screw steam barge is the invention of Mr. St. Clare Byrne, of Liverpool, and the barges are manufactured by Messrs. J. H. Wilson & Co., engineers, of Liverpool. The Wagtail, the first barge made under Mr. Byrne's patent, is now working on the Weaver, and tows three loaded barges on a draught of 2 ft. 9 in. It is found, says *The Engineer*, to work with great ease and steadiness, with very slight disturbance of the water, and without any damage to the canal-banks.

The invention consists, firstly, in the peculiar form or model of the barge or vessel, which is the chief important feature in the whole design, the midship section being in shape as shown in the drawings. This square section is used with a view to prevent settling down when under way; the bow and stern sections being precisely of the same form throughout, that is, a flat floor with square corners rising up longitudinally, and ending in a square bow and stern above the water, the sections throughout being similar in transverse form to that of the midship-section. Although both the fore and after bodies of the vessel rise up in this way, the vertical or side-skin plating does not do so; aft it is continued along on each side to about as far aft as the rudder, and in depth to about the base line of the vessel; forward this side-skin plating may if desired be continued along on each side in length and depth as found upon trial to be necessary.

The second feature of novelty in this invention is the introduction of two pairs of screw propellers, that is, one pair on the starboard side, connected or geared together and driven by a distinct pair or single engines, with a precisely similar arrangement on the port side. The four screw shafts are arranged upon one level athwart ships, and set so as to give the propellers some thrust downwards. The object of the four propellers is to gain propelling surface on a light draught of water, enabling much more power to be developed than



NEW STEAM CANAL TUG.

could be done by the adoption of single or ordinary twin screw arrangements. The rudder is placed aft in the centre of the channel formed by the two projecting side-skins. The advantages claimed for this invention are that the whole of the water upon leaving the vessel—supposing her to be under way—must do so in one direction, that is, between the hanging sides and upwards towards the four screws, equally to each, none closing in upon them from the sides or bilges, as in the case of vessels of ordinary construction. It will be observed that the ordinary centre keel and dead wood aft the stern post and the usual curved shape of frames aft have all been done away with. From the position of the screws, it will at once be seen how completely they are out of harm's way, being quite protected from all damage and breaking of blades against lock piers on canal sides, or otherwise; or from collision with unfriendly—or by accident—flats. Another important advantage arising from this form of vessel is said to be that the damage to the banks of canals will be reduced to a minimum, as there is no suction whatever from the sides towards the screws. A modification of this form of vessel may consist in leaving the after body precisely as described, but the fore body may resolve itself into what may be termed a spoon bow.

[Advertisement.]

AMATEUR WOOD-WORKERS

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GAS-TESTING IN EDINBURGH.

THE committee recently appointed by the Town Council of Edinburgh to investigate the gas supply, have had fitted up in the office of the city analyst (Mr. J. F. King) apparatus worked on the most approved scientific principles. All sunlight is excluded from the testing-room, and the walls are painted black. Two distinct tests are employed, one for illuminating power, and the other for purity. In the first of these the standard with which the gas is compared is that of a sperm candle, which is estimated to burn at the rate of 120 grains per hour. The candle as it burns is weighed with a delicate self-acting balance, and necessary corrections made from the time required to burn 120 grains of sperm. Allowing for the pressure and temperature of the air in measuring the gas, these are reduced to the standard temperature, which is 60 degrees Fahrenheit, and the standard pressure 30 inches of mercury. The passage of the gas to the test jet is equalized by pressure governors, and checked by a delicate metre which indicates to the hundredth part of a cubic foot. The apparatus used for testing the illuminating power, may be described as an oblong box divided into three compartments—a small one at either end for the standard candle and gas-jet, and a longer one in the centre. In this latter is placed a bar having engraved upon it a graduated scale, with the zero at equal distance from the gas-jet and candle. A small movable box on wheels, and containing a disc accurately showing the shadows thrown by the gas-jet, passes along the bar. A view of both sides of the disc is obtained by two mirrors nicely adjusted, and thus the shadows cast by the candle and gas-jet are visible at the same time. The box containing the disc is moved along the bar until it is found that the shadows cast by the gas and candle exactly balance each other, and the point on the index bar at which this correspondence is observed gives the illuminating power of the gas expressed in standard candles. This experiment is repeated ten times to allow a fair average. To ascertain the purity of the article or to detect the presence of such dangerous elements as hydro-sulphuric acid, carbonic acid or ammonia, the gas is passed through a small glass chamber, rendered air-tight by placing it in a bath of mercury. Test papers are suspended on hooks in this chamber, and the gas streaming against these papers the nature of the impurities is detected by the chemical reactions which ensue.

MAGNETISM OF STEEL.

AS INFLUENCED BY ITS CARBON AND ITS HARDNESS.

FOR the measurement of the magnetism which different varieties of steel are capable of receiving, according to the carbon they contain and their degree of hardness, M. Trève (*Comptes Rendus*, abstracted by Stummer's *Ingenieur*) had fifteen steel rods prepared, which he grouped into five rows, of three each. Each group had a varying proportion of carbon, namely, A 0.950 per cent.; B 0.550; C 0.500; D 0.450, and E 0.250 per cent. The rods in each group received a different hardening: No. 1 was heated up to 767 deg. C., and hardened in water of 10 deg.; No. 2 was heated to 800 deg., and hardened in water of 100 deg.; No. 3 was heated up to 776 deg., and hardened in oil of 10 deg. The rods were magetized to saturation, and their magnetism measured. The results of these measurements are given in a table, from which we make the following deductions:

Rod A, with hardening No. 1, gave the highest magnetism, namely, forty-seven; with hardening No. 2, the magnetism measured forty-four; with No. 3, it measured forty-three. A comparison of rods A and E, both at hardness No. 1, show the great influence of the carbon, since, while the magnetism of A was forty-seven, that of E was only thirteen. The influence of the hardening is small when the proportion of carbon is large, but becomes more manifest as the proportion of carbon decreases. The measurements show with precision the influence of the proportion of the contained carbon; the magnetism rising with it, as shown by the following table:

A_1	47	B_1	45	C_1	42.5	D_1	33.5	E_1	13
A_2	44	B_2	30	C_2	30	D_2	22	E_2	10
A_3	43	B_3	37	C_3	37	D_3	29	E_3	12

M. Trève has constructed curves according to these values, showing these results more plainly. A comparison of these curves with the curves of elasticity of these steels shows that as the carbon gives steel its elasticity, it bestows upon it also its magnetic capacity.

INTELLIGENCE OF ANIMALS.

MANY stories have been told of Sir Edwin Landseer's fondness for dogs, and the attachment shown by his various pets. Tiney, a little white terrier, was the latest companion of the painter. A brief biography, accompanying a portrait of Tiney, in the "Animal World," says that he readily learned his master's will, and equally understood his fun. The painter and his brothers and sisters found no difficulty in teaching him many tricks. He regularly fetched the morning newspaper from the kitchen to his master's bed, and found a daily reward in the caresses of his benefactor. He as punctually carried up his patron's boots, making two journeys in doing such duty. Dogs reason, we have often said; and certainly Tiney did one morning, when he thought that it would save himself a second journey if he could take up the two boots at one time. Consequently he placed the boots together in a favorable position to enable him to grasp both with his mouth, and having gripped them he started of with apparent success and glee. His enthusiasm was, however, checked on the way by many impediments, and principally by the steps of the staircase. Though it occupied much more of his strength and time to accomplish the task he had set himself to do than he had expected, Tiney's energy never flagged until he placed both boots together before his master, when he rested, apparently much exhausted, but really perhaps reflecting on his own folly; for never afterward did any one see him attempt to carry more than one boot at a time. Tiney was taught to ask for biscuits; and it is noteworthy that when he begged of Mr. Charles Landseer (who suffers from deafness), he invariably barked in a much louder note than when addressing any other member of the family, a habit which experience and a love of biscuits, we need hardly explain, had taught him to be mindful of. During Landseer's four years' illness, Tiney never left his side. In the garden, on very fine days, the faithful dog would sit coiled up for hours at his master's feet; and shortly before his end, Landseer, embracing his pet, exclaimed, "My dear little white dog; nobody can love me half as much as thou dost."—*Our Own Fireside.*

GALVANIC DEPOSITION OF BISMUTH.

BERTRAND succeeds in obtaining a galvanic deposit of bismuth by employing a double chloride of bismuth and ammonium. This salt is white, crystalline, very soluble in water, and is not precipitated by a slight excess of hydrochloric acid. It is best to operate in the cold and with a solution of from 25 to 30 grammes of the salt in a litre. Precipitation is easily effected by a single Bunsen element, with a Daniell's it is slower. At the end of the operation the brass or copper objects have a blackish tint, below which the bismuth, which adheres firmly, appears with its characteristic lustre, midway between that of antimony and old silver. The deposit takes a fine polish. In an analogous manner a double chloride of antimony and ammonia gives a deposit of antimony.

[Nature.]

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS.*

THE address of the President of a Section would year by year possess an appropriate interest, if it could always consist of an exposition of the progress made during the past year in the department of science which the Section embraces. And many of the addresses to this and other sections have conformed to this pattern with marked success.

But the adequate preparation of an address shaped in this approved mould would require a range of experience and a grasp of thought such as few possess; and custom has wisely sanctioned a type of address which, though less appropriate to the occasion, need not be either uninteresting or inapposite. And we, in this Section, have not to search far for instances in which its President has charmed and instructed us by a masterful exposition of some single subject in practical science, or by a timely reminder of the improvident manner in which we deal with some precious store of natural wealth.

I must express a hope that it will not be regarded as a conversion of liberty into license, if the subject I have chosen obliges me to introduce a further innovation, and to use diagrams and experiments in order to make my meaning clear.

I propose to treat of certain of the fundamental principles which govern the behavior of fluid, and this with special reference to the resistance of ships. By the term "resistance," I mean the opposing force which a ship experiences in its progress through the water.

Considering the immense aggregate amount of power expended in the propulsion of ships, or, in other words, in overcoming the resistance of ships, I trust you will look favorably on an attempt to elucidate the causes of this resistance. It is true that improved results in ship-building have been obtained through accumulated experience; but it unfortunately happens that many of the theories by which this experience is commonly interpreted are interwoven with fundamental fallacies, which, passing for principles, lead to mischievous results when again applied beyond the limits of actual experience.

The resistance experienced by ships is but a branch of the general question of the forces which act on a body moving through a fluid, and has, within a comparatively recent period, been placed in an entirely new light by what is commonly called the theory of stream-lines.

The theory as a whole involves mathematics of the highest order, reaching alike beyond my ken and my purpose; but I believe that, so far as it concerns the resistance of ships, it can be sufficiently understood without the help of technical mathematics; and I will endeavor to explain the course which I have myself found most conducive to its easy apprehension.

It is convenient to consider first the case of a completely submerged body moving in a straight line with uniform speed through an unlimited ocean of fluid. A fish in deep water, a submarine motive-torpedo, a sounding lead while descending through the water, if moving at uniform speed, are all examples of the case I am dealing with.

It is a common but erroneous belief that a body thus moving, experiences resistance to its onward motion by an increase of pressure on its head end, and a diminution of pressure on its tail end. It is thus supposed that the entire head end of the body has to keep on exerting pressure to drive the fluid out of the way, to force a passage for the body, and that the entire tail end has to keep on exerting a kind of suction on the fluid to induce it to close in again—that there is, in fact, what is termed *plus* pressure throughout the head end of the body, and *minus* pressure or partial vacuum throughout the tail end.

This is not so; the resistance to the progress of the body is not due to these causes. The theory of stream-lines discloses to us the startling but true proposition, that a submerged body, if moving at a uniform speed through a perfect fluid, would encounter no resistance whatever. By a perfect fluid, I mean a fluid which is free from viscosity, or quasi-solidity, and in which no friction is caused by the sliding of the particles of the fluid past one another, or past the surface of the body.

The property which I describe as "quasi-solidity" must not be confused with that which persons have in their minds when they use the term "solid water." When people in this sense speak of water as being "solid," they refer to the *sensation* of solidity experienced on striking the water-surface with the hand, or to the reaction encountered by an oar-blade or propeller. What I mean by "quasi-solidity" is the sort of stiffness which is conspicuous in tar or liquid mud; and this property undoubtedly exists in water, though in a very small degree. But the sensation of solid reaction which is encountered by the hand or the oar-blade is not in any way due to this property, but to the *inertia* of the water: it is in effect this inertia which is erroneously termed solidity; and this inertia is possessed by the perfect fluid, with which we are going to deal, as fully as by water. Nevertheless it is true, as I am presently going to show you, that the perfect fluid would offer no resistance to a submerged body moving through it at a steady speed. It will be seen that the apparent contradiction in terms which I have just advanced is cleared up by the circumstance, that in the one case we are dealing with steady motion, and in the other case with the initiation or growth of motion.

In the case of a completely submerged body in the midst of an ocean of perfect fluid, unlimited in every direction, I need hardly argue that it is immaterial whether we consider the body as moving uniformly through the ocean of fluid, or the ocean of fluid as moving uniformly past the body.

The proposition that the motion of a body through a perfect fluid is unresisted, or, what is the same thing, that the motion of a perfect fluid past a body has no tendency to push it in the direction in which the fluid is flowing, is a novel one to many persons; and to such it must seem extremely startling. It arises from a general principle of fluid motion, which I shall presently put before you in detail—namely, that to cause a perfect fluid to change its condition of flow in any manner whatever, and ultimately to return to its original condition of flow, does not require, nay, does not admit of, the expenditure of any power, whether the fluid be caused to flow in a curved path, as it must do in order to get round a stationary body which stands in its way, or to flow with altered speed, as it must do in order to get through the local contraction of channel which the presence of the stationary body practically creates. Power, it may indeed be said, is first expended, and force exerted to communicate certain motions to the fluid; but that same power will ultimately be given back, and the force counterbalanced, when the fluid yields up the motion which has been communicated to it, and returns to its original condition.

I shall commence by illustrating the action on a small scale by fluid flowing through variously shaped pipes; and I must premise that in the greater part of what I shall have to say, I shall not require to take account of absolute hydrostatic pressures. The flow of water through pipes is uninfluenced by the absolute pressure of the water.

I will begin with a very simple case, which I will treat in some detail, and which will serve to show the nature of the argument I am about to submit to you.

Suppose a rigid pipe of uniform sectional area, of the form shown in Fig. 1, something like the form of the water-line of a vessel.

The portions AB, BC, CD, DE are supposed to be equal in length, and of the same curvature, the pipe terminating at E in exactly the same straight line in which it commenced at A, so that its figure is perfectly symmetric on either side of C, the middle point of its length.

Let us now assume that the pipe has a stream of perfect

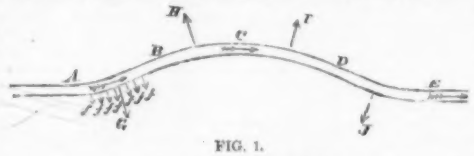


FIG. 1.

fluid running through it from A towards E, and that the pipe is free to move bodily endways.

It is not unnatural to assume at first sight that the tendency of the fluid would be to push the pipe forward, in virtue of the opposing surfaces offered by the bends in it—that both the divergence between A and C from the original line at A, and the return between C and E to that line at E, would place parts of the interior surface of the pipe in some manner in opposition to the stream or flow, and that the flow thus obstructed would drive the pipe forward; but if we endeavor to build up these supposed causes in detail, we find the reasoning to be illusory.

I will now trace the results which can be established by correct reasoning.

The surface being assumed to be smooth, the fluid, being a perfect fluid, can exercise no drag by friction or otherwise on the side of the pipe in the direction of its length, and in fact can exercise no force on the side of the pipe, except at right angles to it. Now the fluid flowing round the curve from A to B will, no doubt, have to be deflected from its course, and, by what is commonly known as contrifugal action, will press against the outer side of the curve, and open with a determinable force. The magnitude and direction of this force at each portion of the curve of the pipe between A and B are represented by the small arrows marked *f*; and the aggregate of these forces between A and B is represented by the larger arrow marked G. In the same way the forces acting on the parts BC, CD, and DE are indicated by the arrows H, I, and J, and as the conditions under which the fluid passes along each of the successive parts of the pipe are precisely alike, it follows that the four forces are exactly equal, and, as shown by the arrows in the diagram, they exactly neutralize one another in virtue of their respective directions; and therefore the whole pipe from A to E, considered as a rigid single structure, is subject to no disturbing force by reason of the fluid running through it.

Though this conclusion that the pipe is not pushed endways may appear on reflection so obvious as to have scarcely needed elaborate proof, I hope that it has not seemed needless, even though tedious, to follow somewhat in detail the forces that act, and which are, under the assumed conditions, the *only* forces that act, on a symmetrical pipe such as I have supposed.

Having shown that in the case of this special symmetrically curved pipe the flow of a perfect fluid through it does not tend to push it endways, I will now proceed to show that this is also the case whatever may be the outline of the pipe, provided that its beginning and end are in the same straight line.

Assume a pipe bent, and its ends joined so as to form a complete circular ring, and the fluid within it running with velocity round the circle. This fluid, by centrifugal force, exercises a uniform outward pressure on every part of the uniform curve; and this is the only force the fluid can exert. This pressure tends to tear the ring asunder, and causes a uniform longitudinal tension on each part of the ring, in the same manner as the pressure within a cylindrical boiler makes a uniform tension on the shell of the boiler.

Now, in the case of fluid running round within rings of various diameter, just as in the case of railway trains running round curves of various diameter, if the velocity along the curve remain the same, the outward pressure on each part of the circumference is less, in proportion as the diameter becomes greater; but the circumferential tension of the pipe is in direct proportion to the pressure and to the diameter; and since the pressure has been shown to be inversely as the diameter, the tension for a given velocity will be the same, whatever be the diameter.

Thus, if we take a ring of doubled diameter, if the velocity is unchanged, the outward pressure per lineal inch will be halved; but this halved pressure, acting with the doubled diameter, will give the same circumferential tension.

Now this longitudinal tension is the same at every part of the ring; and if we cut out a piece of the ring, and supply the longitudinal tension at the ends of the piece, by attaching two straight pipes to it tangentially (see Fig. 2), and if we maintain the flow of the fluid through it, the curved portion of the pipe will be under just the same strains as when it

FIG. 2.

formed part of the complete ring. It will be subject merely to a longitudinal tension; and if the pipe thus formed be flexible, and fasten at the ends, the flow of fluid through it will not tend to disturb it in any way. Whatever be the diameter of the ring out of which the piece is assumed to be cut, and whatever be the length of the segment cut out of it, we have seen that the longitudinal tension will be the same if the fluid be moving at the same velocity; so that, if we piece together any number of such bends of any lengths and any curvatures to form a pipe of any shape, such pipe, if flexible and fastened at the ends (see Fig. 3), will not be disturbed

FIG. 3.

by the flow of fluid through it; and the equilibrium of each portion and of the whole of the combined pipe will be satisfied by a uniform tension along it.

Further, if the two ends of the pipe are in the same straight line, pointing away from one another (see Fig. 4), since the

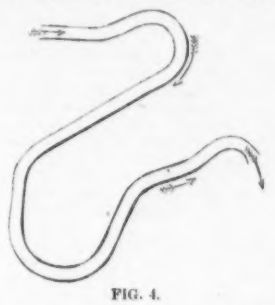


FIG. 4.

tensions on the ends of the pipe are equal and opposite, the flow of the fluid through it does not tend to push it bodily endways.*

This is the point which it was my object to prove; but in the course of this proof there has incidentally appeared the further proposition, that a flexible tortuous pipe, if fastened at the ends, will not tend to be disturbed in any way by the flow of fluid through it. This proposition may to some persons seem at first sight to be so paradoxical as to cast some doubt on the validity of the reasoning which has been used; but the proposition is nevertheless true, as can be proved by a closely analogous experiment, as follows:

Imagine the ends of the flexible tortuous pipe to be joined so as to form a closed figure (see Fig. 5), there will then be no need for the imaginary fastenings at the ends, since each end will supply the fastening to the other. Then substitute for the fluid flowing round the circuit of the pipe, a flexible chain, running in the same path. In this case the centrifugal forces of the chain running in its curved path are similar to

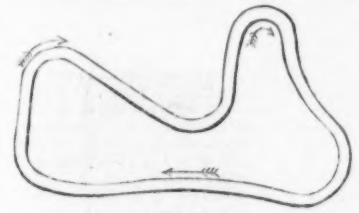


FIG. 5.

those of the fluid flowing in the pipe; and the longitudinal tension of the chain represents in every particular the longitudinal tension on the pipe.

As a simple form of this experiment, if a chain be set rotating at a very high velocity over a pulley in the manner shown in Fig. 6, it will be seen that the centrifugal forces do not tend to disturb the path of the running chain; and, indeed, the velocity being extremely great, the forces, in fact, tend to preserve the path of the chain in opposition to any

FIG. 6.

FIG. 7.

disturbing cause. On the other hand, if by sufficient force we disturb it from its path, it tends to retain the new figure which has been thus imposed upon it (see Fig. 7).

The apparatus with which I am about to verify this proposition has been lent to me by Sir W. Thomson. It is one which he has used on many occasions for the same purpose; and I must add that the proposition in his hands has formed the basis of conclusions incomparably deeper and more important than those to which I am now directing your attention.

You observe the chain when at rest hangs in the ordinary catenary form, from a large pulley with a very wide-mouthed groove and mounted in a frame which is secured to the ceiling. By a simple arrangement of multiplying bands the pulley is driven at a high speed, carrying the chain round by the frictional adhesion of its upper semi-circumference. When at its highest speed the chain travels about 40 per second.

(To be continued.)

* Address to the Mechanical Section of the British Association, Bristol, by William Froude, C.E., M.A., F.R.S., President of the Section. Revised and extended by the author.—*Nature*.

* See Supplementary Note A.

[The American Medical Journal.]

BACTERIA AS A CAUSE OF DISEASE.

By S. H. POTTER, M.D.

HISTOLOGY.—Leeuwenhoek, in Holland, first observed bacteria about two hundred years ago, chiefly in the matter picked from his teeth, though he had habitually brushed them after every meal. He described them as animal organizations, and the larger as eels; because their motions were so active, he was "obliged to kill one before he could portray it."

About one hundred years afterward, Muller classified the forms then known. After great improvements in microscopes, Ehrenberg, in 1820, completed their classification, and published a book in 1838 grouping the different forms in one family—the *vibrionida*—still believing them to be animals. His treatise, entitled "Ifusionsthierchen," was the settled authority until about ten years since. About 1866, Robin questioned the correctness of the classification, and showed that the ordinary red bacteria found in the mouth could develop into the long-thread bacteria and filaments of leptothrix. His theory was generally rejected until 1873, when Frod. Cohn published a new classification based upon the absence of such relations. The reason of such varied impressions is because of the minuteness of these organisms which baffled all attempts to cultivate them under the microscope. In "wet chambers" they have failed to reveal the secrets of their development, on account of the abnormal conditions in which they are necessarily placed. A depth of liquid is essential, as also the presence of air, and protection against shocks and jars and the movement of the liquid. They can only be studied by comparing the forms found at long intervals during an extended period of time, either when cultivated artificially or when growing spontaneously under natural conditions.

Billroth used for observations the yellowish mould formed on the wall of his laboratory, where the water leaked slowly from a loose faucet. He traced the whole series of changes, from the spore to the long filaments, and the nature and importance of peculiar glistening, spherical bodies often found in infusions of bacteria, termed *Dauersporen*—durable spores. These form mirococci in their interior, which are set free by the bursting of an envelope. They are capable of multiplication by scission, or of lengthening into bacteria. Their vitality is surprising. They are not destroyed by boiling, freezing or drying. He kept some dry eight years, and they germinated. It required a temperature of 392 Fahr. to destroy them.

Bacteria are more readily affected by cold or heat than the *Dauersporen*. Their motions cease at near the freezing-point, but, carried below zero, their activity reappears as the liquid is raised to 40° or 45°. A temperature of 215° is required to kill them in five months.

The researches of Pasteur and others into the nature of fermentation and decomposition, the exciting cause being low forms of vegetable and animal organisms, and which were the prolific source of many diseases, stimulated general investigation in most of the pathological laboratories of Europe almost exclusively for a long period.

Pasteur's researches; the lectures and publications of Tyndall, Huxley and others; the earnest and heated discussions over the great question of "Spontaneous Generation" during the twenty years past, give great and renewed prominence to this subject, throughout the religious and scientific world, as one of vital importance. Prof. Wyman, of Cambridge, pertinently stated: "The issue between the advocates and opponents of the doctrine of spontaneous generation clearly turns upon the extent to which it can be proved that living beings resist the action of water at a high temperature."—*A. J. of Science and Art, September*, 1867.

Pathology of Disease caused by Bacteria.—Now, the various varieties of bacteria are known to be plants, not animals, and representing the different periods of development.

Drs. Cose and Feltz, of Strasburg, experimented seven years—from 1865 to 1872—and claimed the virulence of putrid matter was due to the presence and growth of bacteria, and that the blood of an animal poisoned with such matter was virulent to a high degree, increasing by successive inoculations.

Davaine, of Paris, repeated the experiments, which were so surprising that for several months the subject of *septicæmia* occupied medical discussions in Paris almost exclusively. A rabbit inoculated with blood putrefied in the open air, fifteen drops were required to kill it. Continual successive inoculations from one septicæmic animal to another, and $\frac{1}{10}$ to $\frac{1}{100}$ of a drop would kill the fifth; $\frac{1}{1000}$ to $\frac{1}{10000}$ would kill the tenth; and while for the twenty-fifth the one ten-trillionth part of a drop was fatal. The minimum dose that would certainly kill was placed by numerous experimenters at one-millionth part of a drop. The experiments were repeated and the conclusions tested in almost every pathological laboratory in Europe.

At various times articles have appeared denying the virulence of bacteria; the earliest by M. Ominus, in April, 1873. From all investigations to the present time the conclusion reached is, that the virus of putrid infection is not an organized ferment, not bacteria, but an albuminoid substance. Parnem held this view twenty years ago, and reasserted it in Virchow's Archives, July, 1874, and the weight of testimony is to establish this opinion.

Clinical observation has been used to refute or confirm the conclusions of experimental pathology, and both have clearly demonstrated that the poisonous processes can begin in the human body and proceed without the presence of bacteria, and that bacteria may be present in large quantities without the slightest symptom of any poisonous complication. At various times articles have appeared denying the virulence of bacteria; in 1873, M. Ominus, experimenting under the directions of Prof. Robin, seems to have settled the question.

He placed putrefying blood in a dialagtic membrane bag, and immersed the whole in distilled water, which, after a few hours, was found to be filled with bacteria. Inoculation with the blood produced the usual results, but inoculation with the water caused no septic symptoms; but the same blood, when subjected to various processes which destroyed or removed the bacteria, retained all its virulence, and hence it follows that the virus of putrid infection is not an organized ferment, not bacteria, but an albuminoid substance. Parnem held this view twenty years ago, and reasserted this belief in Virchow's Archives for July, 1874. During the last year pathological and clinical observations agree that the poisonous process in question can begin in the human body and proceed without the presence of bacteria, and that they may be present in large quantities without the least symptom of poisonous complication.

It is now generally conceded that "the *role* of bacteria, so far as disease is concerned, is, that they have no power to excite it; but they are able to *absorb the poison* (ferment?), which is capable of producing disease—to "fix it," as it is termed—and to give up to any tissue with which they may come in contact, thus acting as *carriers* of contagion; then, after the abnormal process has been commenced in the body, a change is effected in the tissues, which renders them suitable for the rapid growth and multiplication of bacteria, and which in turn augment the change in the tissues, and thus a vicious circle is formed, rendering *diphtheria, septicæmia, vaccina, typhoid fever, many ulcers, erysipelas*, etc., malignant, and too often fatal. Any agent, as chlorine, iron, carbolic acid, etc., which has the power to destroy the life of the bacteria, or to prevent their multiplication, breaks the circle, and renders a cure possible.

The influence of bacteria in fermentation is yet undecided. All chemists admit that these, or similar organisms, are invariably present in some fermentations—red bacteria in putrefaction, the yeast-plant in alcoholic fermentation. Some claim that the process is due to the vitality and growth of these plants; others, that this growth is not a cause, but effect; the third party holds that the plants secrete the ferment. Liebig held that fermentation is an action which is produced in a fermentable substance by dead albuminous matter, and which is in spontaneous decomposition; that is, fermentation is a correlative phenomenon of death. Pasteur, in opposition, maintains that fermentation occurs only when a microscopical vegetable organism nourishes itself and multiplies at the expense of a part of a fermentable substance. All fermentation is accompanied by life; both processes (fermentation and growth) begin and end simultaneously; that is, fermentation is a correlative phenomenon of life—precisely the reverse of Liebig's theory.

Spontaneous generation and fermentation seem at present inseparable. Those who believe in the former claim that life originates in a new combination of elements, *archebiosis*—a combination similar to crystallization—and that the same causes which induce chemical decompositions and subsequent combinations, known as fermentation, also bring about the combinations which result in life.

Advancing knowledge must furnish new and better means of observation to discover still lower and more minute forms of microscopical life before any definite proof can appear of *spontaneous generation* to explain an unknown mode of the production of life. Perhaps there is no more intricate or interesting question than this to the real student of physiology and pathology, two of our great collateral sciences in medicine. Reading physicians can not fail to take deep interest in the subject, over which theologians and scientists are in earnest combat, from the great centres to the circumference of civilization.

A NOVEL IRON CHURCH-ROOF.

A NOVEL iron church-roof of some pretensions has been constructed by Messrs. Morewood & Co., of Bilston, for a church for the Republic of Costa Rica. The plan of the church is a long rectangle, with semicircular end, 156 ft. long by 47 ft. 7 in. in span. The west, or square end, is hipped with half and jack-hip principal. The hip principals meet and rest upon a cast-iron pillar in the centre. There are ten ordinary principals, or trusses, composed of rafters (about a third pitch), connected to curved plate-ribs of ⊥ section, by radiating bars of cross-section forming panels—these panels being relieved by plate cusps, forming a series of Gothic-shaped foliations. The distance in the centre of rafter, between it and the under rib, is about 3 ft. 6 in., and these curved ribs cross at the top and are riveted to principals. At their intersection is a pendant piece of cross-section, formed of plate and riveted angle-irons. The lower ends of the curved ribs continue to some distance below the wall plates, and are riveted to wall pieces. Triangular panels are thus formed at the springing and at the apex. The rafters are of plate iron of T shape, an angle-iron being riveted through each side. The rib is of similar construction, each measuring about 6 in. in the web by about 4 in. across the flanges. At the circular end of the church there are nine radiating half-principals, which centre on a cast-iron pillar as at the other end. It was found on erecting the roof temporarily, previous to shipment, that the weight was well carried down the walls, and that little thrust existed. Horizontal purlins, about 4 ft. 6 in. apart, carry boarding covered with galvanized corrugated sheeting. The hips are lead ridge caps. The roof, at least, has the merit of adapting iron in a way that at least we think deserves attention by architects. Apparent depth and a certain ecclesiastical character is given by this kind of open framing; and we believe, as we have suggested more than once, that framed ribs and pillars of good design are more satisfactory, artistically, than crude castings and solid riveted features.—*The Building News.*

FISH AT THE CENTENNIAL.

ONE portion of the Centennial fish display will be held in the United States Government Building, and the other in the Agricultural department. The former, directed by Professors Baird and Henry, will consist of artificial specimens, colored and finished after nature. This exhibition can, therefore, be made to represent most of the individuals in the known piscatorial world, and will possess the greater attraction for natural scientists. The display by the Agricultural Bureau, which is to comprise fish prepared and dried for commerce, and also live specimens swimming in large glass aquaria of fresh or salt water, will be the more interesting to the general public. It is intended to construct aquaria similar to those in Brighton and Naples.

A WOODEN NORWEGIAN CHURCH.

BORGUND Church, one of the most interesting buildings in Norway, is described as follows by a correspondent of the *Hour:* "It is built of wood plentifully smeared with pitch, and although covering a very small area of ground, it is constructed with roof rising above roof, each smaller than that below, in a manner which has been irreverently compared to a coachman's overcoat. Notwithstanding this complication of design, the church is complete in its general details. It possesses nave, chancel, and apse, and a low corridor runs all round the building outside. The outside appearance of the apse is something like a large beehive surmounted by a cross. Travelling westwards the eye finds the chancel, which has two roofs, one above the other, as well as the roof of the corridor which goes round that part of the building. The nave has one main roof with two others—one of them belonging to the corridors—below it, looking like large wooden flaps, and a turret above it, which is itself composed of three roofs, and is surmounted by a weathercock. The gables at the end of each roof, and above the three doorways of the north, south, and west sides of the church are ornamented with crosses. Inside there are wooden pillars like the masts of a ship, and wooden arches, so that the whole structure is entirely of wood, there being no glass to the windows, but only shutters, and the roofs being constructed of wooden shingles overlapping one another like scales. The church is said to be as old as the twelfth century, and no one who sees it can help wondering who was the gifted person who set so elaborate an example of his genius as a place of worship on this desolate spot. A picture is sometimes incomplete without what artists call an echo, and this is supplied by the new Borgund Church, a feeble imitation in painted wood and slate of the old Borgund Church, which is now disused."

A SIMPLE METHOD OF COMPARING THE HARDNESS OF DIFFERENT KINDS OF STEEL ELECTROMAGNETICALLY.

By M. V. WALTENHOFEN.

WHEN a hardened steel bar is drawn through a magnetizing spiral, it is generally found that one half is more strongly attracted than the other: this is due to non-homogeneity in hardness of the bar; thus a method of testing steel bars for hardness is suggested. Of the steels to be compared, bars of equal length and weight are procured; then one is hung vertically, with copper wire, from one end of a hydrostatic balance, which is then brought to equilibrium by putting weights in the scale. For the ordinary water-vessel a magnetizing spiral is substituted, and the bar is allowed to hang to the extent of a half in the hollow part. If a current be forthwith sent through the spiral the bar will be drawn wholly in, and the balance will shake. To avoid this, the equilibrated bar is held with the fingers; then the circuit closed; then weights are put into the scale till they are felt to counterbalance the force which draws the bar into the spiral; then the fingers are withdrawn, and the bar is put in equilibrium, so that a small additional weight would suffice to draw it out of the spiral altogether. As the bar will not hang exactly in the middle of the spiral, but be attracted to one side when the current flows, a tube of smooth glass or brass should be put in as lining, to prevent friction. A rheostat and galvanometer are also necessary for regulation of the current. With 1 Bunsen element, 144 windings of a copper wire 3 m.m. thick (the spiral being 91 m.m. high and 3 c.m. wide), and an iron bar 10 c.m. long and 20 grms. weight, 87 grms. were necessary to overcome the attraction of the spiral: with a similar hardened steel bar 52 grms. were required. For steel of little hardness, or unhardened, numbers were obtained between these.—*Dingler—Electrical News.*

EXPERIMENTS ON ELECTROSTATIC INDUCTION.

By M. GOVI.

THESE are to show that induced electricity of the first kind has potential. An electrified spherical body is supported under two pith balls, which are hung by linen thread from an insulated ring. At the very first the balls diverge, and the divergence increases when they are made to communicate with the earth. If this divergence (says M. Govi) arose from curvilinear induction by the inducing sphere, as has been supposed, it should cease or diminish, on the induction being suppressed; but this is not the case. On discharging the inductor with an uninsulated metallic point, the two pendula may be made to separate further. The reason is that the inductor, far from separating the balls by curvilinear induction, exercises on them an attraction which tends to bring them together. If we understand by *electric potential* the effort of electrified bodies to approach or withdraw from each other, the separation of the small pendula should still prove the potential of the induced electricity opposed to the inducing, were it even demonstrated that we must attribute it to what Faraday has denominated curvilinear induction. The potential of the induced electricity is still more distinctly manifested when the induced body is terminated by a fine point turned directly towards the inductor. If, in this case, the air being very dry, and the supports of the induced body perfectly insulating, the induction be allowed to act a few seconds, one finds that immediately after discharge of the inductor the induced body retains a perceptible charge of electricity of the same name with that of the inductor. All the other phenomena which have produced in some minds the contradictory idea of an induced electricity without potential are easily explained if we take into account the influence exercised on the inductor by bodies, insulated or not, which are brought near the induced.—*Journal de Physique.*

DEEP SHAFTS AND MINES.

DURING last May the shaft of the argentiferous lead mines of Przibram attained a depth of 3280 ft. After various trials, borings, etc., dating from the fourteenth century, actual working commenced at these mines in 1779. In 1800 the shafts were 870 ft. deep, and 2345 ft. in 1865. During the first ninety-six years of working the annual increase of depth was 34 ft., and in the last ten years it has been regularly increased 88.56 ft. The following table gives the depths and situations of the deepest mines.

Country.	District.	Nature of Mineral.	Name of Pit or Mine.	Depth ft.
Wurtemburg	Jagstfeld	Salt	Friedrichshall	541.4
Russia	Turjinsk	Copper		606.8
Bavaria	Stockholm	Coal	Max	859.9
Portugal	Palhal	Copper	Taylor	1023
Baden	Hagenbach	Coal		1078
Holland	Kerkrade	Coal	Wilhelm	1099
Sweden	Berebo	Copper		1377
Italy	Gavarrano	Lignite	Monte-Masio	1443
Spain	Canada	Silver	La Luerti	1548
Hungary	Schenmitz	Gold and Silver	Amalia	1771
Norway	Konigsberg	Silver		1869
France	St. Chaumont	Coal	Saint Luc	1976
Great Britain	Wigan	Coal	Rosebridge	2443
Prussia	St. André	Silver	Samon	2532
Saxony	Zwickau	Coal		2657
Belgium	Gilly	Coal	Viviers	2820
Austria	Birkenberg (province of Pirabram)	Silver and lead	Adalbert	3280

Revue Industrielle.

[Engineering and Mining Journal.]

ON THE SUBSTITUTION OF LIQUID, VAPORIZED AND GASEOUS HYDROCARBONS FOR SOLID FUEL IN BLAST-FURNACES.

BY CHARLES PLAGGE.

According to Prof. H. Wurtz's analysis, the commercial crude petroleum may be considered as consisting of :

84 per cent carbon,
14 " " hydrogen,
2 " " oxygen,

100 lbs. petroleum.

Or, assuming the 2 oxygen to be combined with 0.25 H., it will contain :

84 per cent carbon,
13.75 " " hydrogen,
2.25 " " water.

Supposing the petroleum is but incompletely burned, in such a way that its carbon is only converted into carbonic oxide, its hydrogen into water, its siderurgic value will be as follows :

The 84 lbs. of carbon to be converted into carbonic oxide require $75 : 100 = 84 : x = 112$ lbs. oxygen, or 423 lbs. atmospheric air. The products of combustion will consist of :

196 lbs. carbonic oxide,
126 " water,
631.75 " nitrogen.

[NOTE.—In the following, CU°. will represent *caloric units centigrade.*]

84 lbs. carbon burned to carbonic oxide generate $84 \times 2,221 = 186,564$ CU°.
13.75 " hydrogen " " water " $13.75 \times 34,444 = 473,605$ "

Total heat generated by 100 lbs. petroleum = 660,169 "
Deducting the latent heat of the 126 lbs. of water, equal to 126×537 = 67,662 "
we obtain, as heat value of 100 lbs. of petroleum, incompletely burned = 592,507 "

The temperature obtained by the incomplete combustion of petroleum, we find by the equation $592,507 = [196 \times 0.288 + 126 \times 0.847 + 631 \times 0.275]\, x$,

$$\text{or, } x = \frac{592,507}{336} = 1763° \text{ C.}$$

A very different result we obtain by the *complete* combustion of petroleum, by which its carbon is converted into carbonic acid, its hydrogen into water. In that case we find :

84 lbs. carbon burned to carbonic acid require 224 lbs. oxygen, or 861 lbs. of atmospheric air.
13.75 " hydrogen, as stated before, require 110 lbs. oxygen, or 423 lbs. of air.

The products of combustion are :

308 lbs. carbonic acid,
125 " water,
930 " nitrogen.

The heat generated by burning 84 lbs. carbon to carbonic acid is = $84 \times 7900 = 663,600$ CU°.
The heat generated by burning 13.75 lbs. hydrogen to water is (as before) = 473,605 "

Total = 1,137,205 "
Deducting, as before, the latent heat of the 126 lbs. of water = 67,662 "
we obtain, as total available heat from the complete combustion of 100 lbs. petroleum = 1,069,543 "

The temperature thereby obtained is expressed by equation :

$$1,069,543 = [308 \times 0.313 + 126 \times 0.847 + 930 \times 0.275]\, x$$

$$x = \frac{1,069,543}{433} = 2470° \text{ C.}$$

100 lbs. of petroleum, therefore, when burned to carbonic acid and water, produce not only 1,069,543—592,507 = 477,036 CU°. more heat, but also a temperature of 2470 — 1763 = 707° C. higher than when burned merely to carbonic oxide and water.

While, therefore, petroleum, when incompletely burned, is scarcely serviceable for making pig-iron, it becomes very valuable for this purpose when we apply it in such a way that its carbon can be converted into carbonic acid, and its hydrogen into water.

The next point now to be considered will be, what amount of petroleum will be required for the making of 1 ton, of 2240 pounds, of pig-iron? This amount naturally differs according to the ores used. In North-western Pennsylvania it takes, on an average, in cold-blast furnaces, 90 bushels of Connellsville coke, containing 3200 lbs. of carbon, to make 1 ton of pig-iron from magnetic oxide, or a mixture of protoxide and oxide of iron containing 853 lbs. of oxygen, in the amount of ore required to produce 1 ton of pig-iron, which, therefore, requires for its reduction 640 lbs. of carbon, if the latter is converted into carbonic oxide. Of the balance of the carbon used, amounting to $3200 - 640 = 2560$ lbs., 60 lbs. are required for the carbonization of the reduced metal, leaving 2500 lbs. of carbon to effect the dissociation of the oxygen from the iron, and to melt the reduced metal along with the slag materials, and to cover the loss of heat by radiation, waste heat of escaping gases, etc.

The amount of heat required for the dissociation of the oxygen in the iron ore, we can calculate as follows :

1 lb. of oxygen, burned with iron, generates 6212 CU°.

To dissociate, therefore, 853 lbs. of oxygen, combined with the ore producing 1 ton of pig-iron, will require $853 \times 6212 = 5,298,836$ CU° ; from this, however, has to be deducted the heat generated by the burning of the 853 lbs. oxygen, liberated from the ore, with 640 lbs. of carbon, to carbonic oxide, amounting to $640 \times 2221 = 1,321,440$ CU°. It therefore takes 5,298,836 — 1,321,440 = 3,977,396 CU°, or $\frac{3,977,396}{2221} = 1790$ lbs. of carbon to dissociate 1 ton of pig-iron ; and $3200 - 640 + 60 + 1790 = 710$ lbs. of carbon, to cover loss of heat by radiation, for fusion, heat lost with waste gases, etc.

Substituting petroleum for carbon, and conducting the blast-furnace process in such a manner that the petroleum used is all converted into carbonic acid and water, we must consider, first, that of the 84 carbon contained in 100 lbs. petroleum, by being converted into carbonic acid, absorb from the ore = 224 lbs. oxygen.
the 13.75 hydrogen, by being converted into water, absorb 110 " "

100 lbs. petroleum, therefore, take up = 334 lbs. oxygen.
and to reduce 1 ton of pig-iron will require $334 : 853 = 100 : x$, and $x = 256$ lbs. of petroleum, which, burning to carbonic acid, with 853 lbs. oxygen set free by the reduction of the metal, will generate $\frac{256}{100} \times 10,695,543 = 2,738,000$ CU°. We shall, consequently, require for the dissociation of the iron from the oxygen 5298—8362,738,080 = 2,560,806 CU°, or $\frac{2,560,806}{1,069,543} = 239$ lbs of petroleum.

The 710 lbs. of carbon = $710 \times 2221 = 1,576,910$ CU° required for smelting, loss by radiation, waste gases, etc., we can substitute by $\frac{1,576,910}{1,069,543} = 143$ lbs. of patroleum.

The total consumption of petroleum, per 1 ton of pig-iron, will therefore be :

For reduction = 256 lbs.
For dissociation of metal = 239 "
For smelting, loss by waste gases, etc. = 148 "

Total = 643 lbs. $= \frac{643}{6.69} = 96.4$ gallons.

Taking into consideration the much smaller size of furnace required by the substitution of hydrocarbons for solid fuel, the smaller amount of flux required, and more energetic action of the hydrocarbons, we may assume, especially when aided by hot-blast, that it will probably not require more than two barrels of petroleum per one ton of pig-iron ; the substitution of petroleum for solid fuel, therefore, would be very economical in many sections of this country. Still more economical, however, will be the substitution of natural gas for solid fuel, wherever the former is met with, as in many parts of North-western Pennsylvania, New-York, Ohio, Kentucky, West Virginia, etc.

According to the analysis of Prof. Wurtz, of the Bloomfield Gas Company (published in *American Gas-Light Journal*, March, 1870, p. 82), we find the value of the natural gas as follows. The gas contains

82.41 per cent marsh gas			64.81 carbon.
10.11 " carbonic acid			21.31 hydrogen.
4.31 " nitrogen	}	Equal to	0.96 water.
0.23 " oxygen			4.31 nitrogen.
2.94 " illuminating carbon			10.11 carbonic acid.

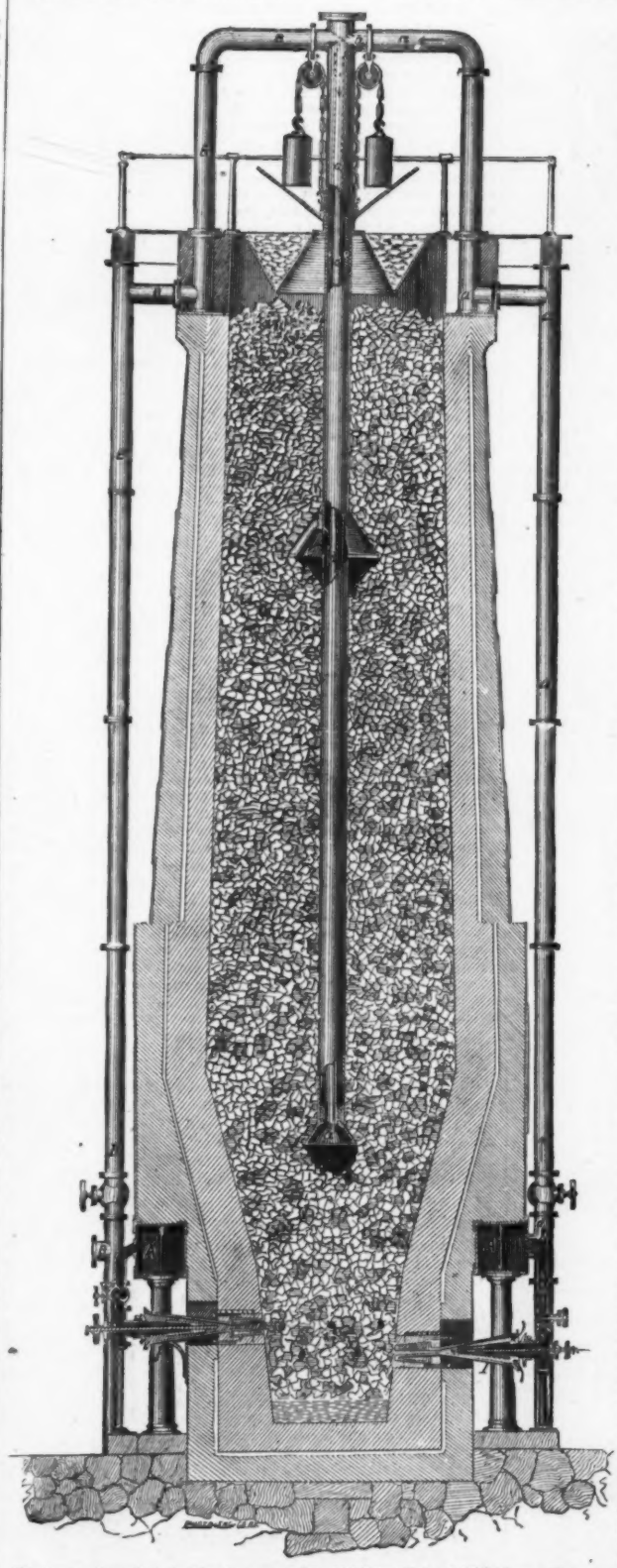
The 64.81 carbon burning to carbonic acid require 170.7 oxygen, contained in 652 lbs. of air ; the 21.31 hydrogen and 0.23 oxygen, burning to water, requires 171.48 oxygen, contained in 655 lbs. of air.
The products of combustion are

244.82 carbonic acid, 192.05 water, 970.16 nitrogen.

64.81 carbon, burning to carbonic acid, generate = $64.81 \times 79.00 = 511999$ CU°.
21.34 hydrogen in water = $21.34 \times 34444 = 735035$ "

Total = 1247034 CU°.
Deducting the latent heat of 192.05 water = 103120 "

We have heat value of 100 lbs. of natural gas = 1143914 CU°.



The temperature of combustion is expressed by $1143914 = 244.8 \times 0.212 + 192 \times 0.847 + 970 \times 0.275$, or $x = \frac{1143914}{481} = 2378°$C.

Incompletely burned to carbonic oxide and water, we obtain 64.81 carbon, burned, to carbonic oxide requires 85.35 oxygen contained in 328 lbs. air.
21.31 hydrogen, burned to water, requires 171.48 oxygen contained in 655 lbs. of air.
The products of incomplete combustion of 100 lbs. natural gas to carbonic oxide and water are :

149.36 carbonic oxide, 192.05 water, 741.50 nitrogen, 10.11 carbonic acid.
64.81 carbon, burning to carbonic oxide, generate = $64.81 \times 2221 = 143943$ CU°.
21.34 hydrogen in water = $21.34 \times 34444 = 735035$ "

Total = 878978 CU°.
Deducting latent heat of water = 103858 "

We find the heat value of 100 lbs. of gas, incompletely burned, 775858 CU°, and the temperature obtained thereby $\frac{775858}{411} = 1887°$C.

These calculations show that liquid, vaporized, or gaseous hydrocarbons can be substituted successfully for solid fuel, only when we apply them in such a way that, by its combustion, it is entirely converted into carbonic acid and water.

Blunt Salisbury proposed the use of petroleum in blast-furnaces, by vaporizing the petroleum with superheated steam, and injecting it with the blast into the chamber of combustion of the furnace. Used in this way, the petroleum vapor must be but partially burned, converting its carbon into carbonic oxide, as the latter is necessary for the reduction of the metal. The temperature which, under these circumstances, can be obtained in the hearth is, as shown before, insufficient to work the furnace to advantage. To avoid these difficulties, instead of introducing the petroleum exclusively into the hearth, together with the blast, I divide the hydrocarbon to be used in such a way that into the zone of combustion only such a part of it is introduced as is wanted to produce the smelting of the reduced iron along with the slag materials, while the balance of the hydrocarbon required for the heating, roasting, reduction, and carbonization of the metal, is injected into the upper part of the furnace (the reducing zone). To introduce the hydrocarbon, and the blast required for the roasting process, I prefer to use a central tube, descending from the trundle down to such a point in the reducing zone as is judged best for working the furnace. To protect this tube (the hydrocarbon tube) against destructive heat, I surround it by an exterior tube of larger diameter, which leaves an annular space for the circulation of hot or cold blast, which latter enters said annular space at the top, circulating around the entire hydrocarbon tube, before it escapes by appropriate openings in the exterior tube into the interior of the furnace, at a certain depth below the upper surface of the charges, but above the level at which the hydrocarbons are admitted into the reducing zone. The outside (air) tube may be protected against destructive heat by a fire-proof lining ; also the outlet-openings for air and hydrocarbon be secured against shaking, and to facilitate their entrance into the interior of the furnace, by umbrella-shaped projections. By this or other equivalent arrangement, the blast introduced into the upper part of the furnace serves both as a protection of the hydrocarbon tube, and to burn all hydrocarbon vapors or gases which may not have been utilized in the reduction and smelting of the iron. The free oxygen admitted into the upper part of the furnace, above the reducing zone, oxidizes the deleterious admixtures of the ore, such as sulphur, phosphorus, etc., and the heat generated thereby assists to expel the carbonic acid and moisture of ore and flux, and to heat and prepare the ore for the reducing zone.

Into the combustion-chamber the liquid, vaporized or gaseous hydrocarbons are introduced with or without the aid of superheated steam, either mixed with the blast or separately from it, in which latter case I prefer to introduce the hydrocarbon at a level somewhat below the level where the blast enters.

The advantages which I claim for my process are : 1st. great saving in fuel (a) on account of the greater heat produced by the perfect combustion of the hydrocarbon with the least amount of blast ; (b) the complete utilization of the waste heat of the escaping gases for heating, roasting, and preparing for the zone of reduction the newly entering charges.

2d. Large increase in the daily output of metal by the great increase of the capacity of the furnace for ore, as no solid fuel is mixed with the ore.

3d. Superior quality of the metal produced, as most of the impurities of the ore and flux are eliminated by the roasting process before the charges enter the zone of reduction.

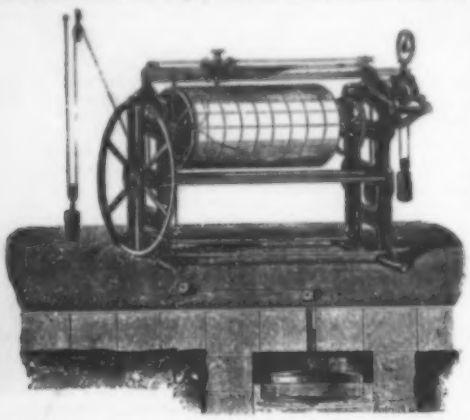
4th. The reduction of the metal is effected at such a low temperature that the least possible amount of impurities are reduced or can combine with the iron.

5th. The reduced and carbonized metal on its way toward the hearth, coming only into contact with neutral or slightly oxidizing or reducing gases (as the metal to be produced may require), can not absorb impurities from the slag material, as is the case in blast-furnaces as heretofore worked, where the reduced metal, on its way from the reducing zone toward the hearth, remains in constant contact with incandescent coal at a high and increasing temperature, and is, besides, exposed to a current of highly deoxidizing gases, which, after the complete reduction of the iron, act mainly upon he impurities of the ore and slag material, which are thereby reduced, and contaminate the reduced metal. In my process, the metal reduced at low temperature, on its way from the reducing to the smelting zone, can not be contaminated by injurious substances, as it comes only in contact with neutral, or slightly oxidizing, or reducing gases, and is subjected to the refining action of the carbonic acid, which acts as a powerful agent upon the removal of sulphur, silicon, or phosphorus, which may have been taken up by the reduced metal, converting them into sulphurous acid, silicic acid, and phosphoric acid.

If the ores contain much phosphorus, I prefer to moisten them with a strong solution of chloride of magnesia (the refuse or mother-liquor of salt-works) or with chloride of manganese. The chloride of magnesia heated to redness is decomposed ; its chlorine combines readily with the phosphorus of the iron, and escapes with the waste gases as perchloride of phosphorus. The chlorine of the chlorides likewise acts upon the carbon of the hydrocarbons, forming bichloride of carbon, which is highly volatile and a powerful resolvent for phosphorus. By using, in the described manner, the upper part of the furnace for heating and roasting the ores before they enter the reducing zone, the sulphur contained in the ore and flux is readily removed, as the steam formed by the combustion of the hydrocarbons decomposes the sulphide of iron as follows : $FeS_2 + H_2O = FeO + 2SH$, which latter, by the free oxygen of the blast introduced into the upper part of the furnace, is burned to SO_2 and H_2O.

NEW SELF-REGISTERING TIDAL AND RIVER-WATER INDICATORS.

THE Tidal Register presented in Fig. 1 is set by an endless cord, with a float represented at the bottom of the cut, and is placed in a reservoir communicating with the waters of the ocean. In these conditions the float is subjected less suddenly to the changes in the level of the liquid. These changes are registered by an apparatus, formed of a large horizontal cylinder, which, under the influence of clock movements, accomplishes a complete rotation in twenty-four hours. The cylinder is covered with a sheet of paper, which is changed every month, and which carries longitudinal divisions, giving on a reduced scale the heights of the tide in meters and centimeters. A slide, mounted with movable rollers on a

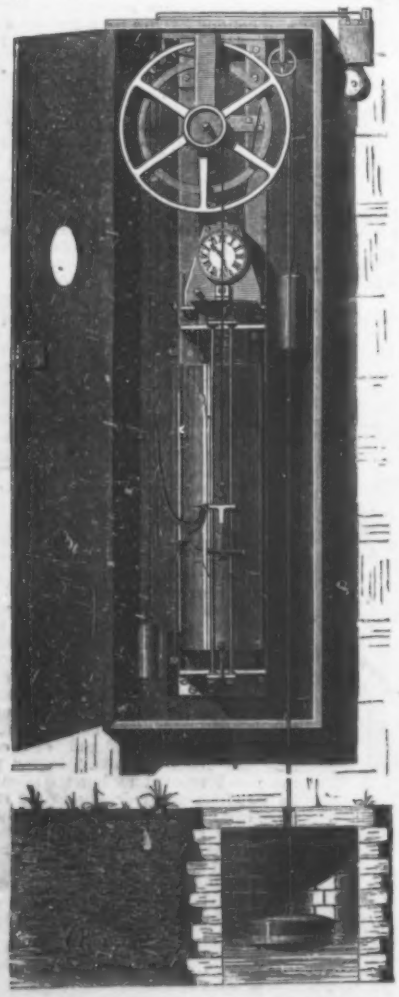


WATER SELF-REGISTERING TIDAL INDICATORS.—FIG. 1.

steel ruler, carries a pencil, which is made to rest against the cylinder by means of a spring. The slide is moved by an endless cord with a small wheel mounted on the axis of a wheel of greater diameter, which receives its movement from the float already mentioned. The diameter of the smallest wheel is to that of the largest one what the unity of a transverse division of the cylinder is to the meter. On a third wheel of medium diameter is attached a cord, which rolls up, and which is drawn in a direction opposite to that of the float fixed to the large wheel.

It follows, when the float rises, that the acting weights draw the three wheels, mounted on this same axis, and keeps the cord of the float tight, be its evolutions what they will.

The pencil is also drawn and traces lines on the paper, the



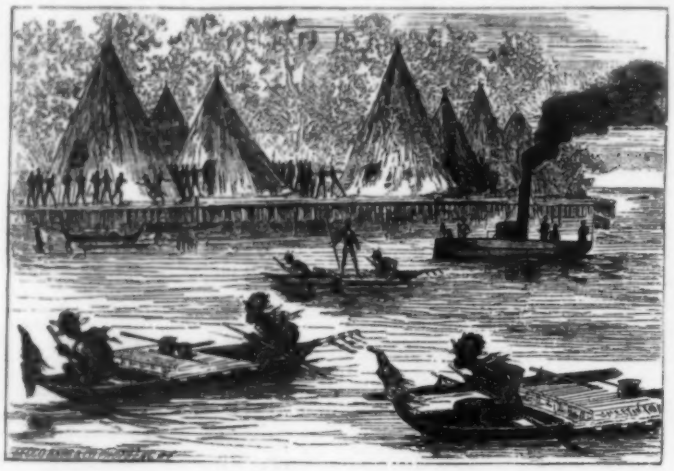
WATER SELF-REGISTER TIDAL INDICATORS.—FIG. 2.

extremities of which is the maximum elevation of the water. A dial, placed above the mechanism of the clock, indicates the moment the apparatus was set in motion.

The river and canal level register consists in superposing the cylinders, motor movements, fly-wheel, etc., in such a manner as to be inclosed in a wooden case, measuring 1.3 meters in height; this apparatus writes, during one or several days, the height of the level of a sea, a river, a canal, or a lock, with the hours corresponding to these changes in elevation. It also indicates the number of times the lock was opened to allow vessels to pass, at what hour of the day or night this opening took place. It also announces, by means of a bell, that a determined level of water has been attained.—*La Nature.*

THE CHALLENGER AT HUMBOLDT BAY.

ON the morning of the 22d January, at the rising of the sun, the *Challenger* found itself in the midst of a fleet of eighty pirogues, the length of which varied from eighteen to twenty feet, and each of which was equipped with five or six men. The platform of the boats was crowded with warriors armed from top to toe. These savages have not woolly hair like negroes; it is rather curly, which makes them proud of it. Their teeth would probably be white, had they not the detestable habit of chewing betel, which destroys and blackens their teeth dreadfully. Their ears are deformed by the monstrous ornaments which they attach to them; their nose, naturally flat, is artificially compressed. They are not, however, as repulsive as they might seem to be by this description. Their tattooing is not as exaggerated as in some cases; the colors with which they mottle themselves harmonize very well with the color of their skin, which is not black, but copper-colored. Their arms are made with great care, and denote real intelligence. Their arrows are made of a very hard wood, and are of great length; though light, they measure from five to six feet. Stone axes were also noticed in their boats. Their taste for fantastical sculpture is quite developed. The prow of their boats is excavated, cut, and ornamented in every possible way. They are very cowardly, and fled before our boat as we approached the land. We there saw their wives, who really do not look as well as their husbands, but over whom the latter watch with a care worthy of the heroes of Molliére. Their huts are very simple in construction; the essential part is a mast twenty feet in length, which is raised in the centre, against which rest the flexible inclined pieces, gracefully bent under the weight of the foliage roof which they support.—*La Nature.*



THE CHALLENGER AT HUMBOLDT BAY.

THE GREAT GLOBES OF THE FRENCH NATIONAL LIBRARY.

A VERY beautiful and curious exposition, devoted to the history of geography, took place in the great gallery of the National Library. Among the exhibits were two of great interest, consisting of two large globes executed by Marc-Vincent Coronelli. The diameter of each globe is 12 feet, which gives a circumference of 37 ft. 8½ in.; they are formed of solid wood frames, covered by a linen material, on which the painting is executed; the meridians and horizons are of bronze; the latter are supported by eight columns of the same material, and the meridians are supported by two bronze legs which are enamelled with exquisite taste. Between the four consoles, which form the legs of the meridian, is placed under each globe a large bronze and marble compass; these mark the variations of the magnetic needle, which was East, nine degrees and six minutes, at the beginning of 1704.

On the celestial globe, painted in blue, figure the fixed stars which are visible to the naked eye, and the constellations which comprise them, according to ancient and modern astronomers, together with the course followed by some comets known before the eighteenth century.

The sphere also shows the position of all the planets at the moment of the birth of Louis the Great. This last detail is elsewhere indicated by an inscription on a copper plate, of which the following is a translation:

To the august majesty of
Louis the Great, the invincible,
the happy, the wise, the conqueror,
Cæsar Cardinal of Estrées
has consecrated this celestial globe,
on which the stars are placed as they
witnessed the birth of this
glorious monarch,
in order to preserve to eternity the
fixed image
of that happy disposition
in which France received the greatest
gift that heaven ever bestowed
upon earth.
MDCLXXXIII.

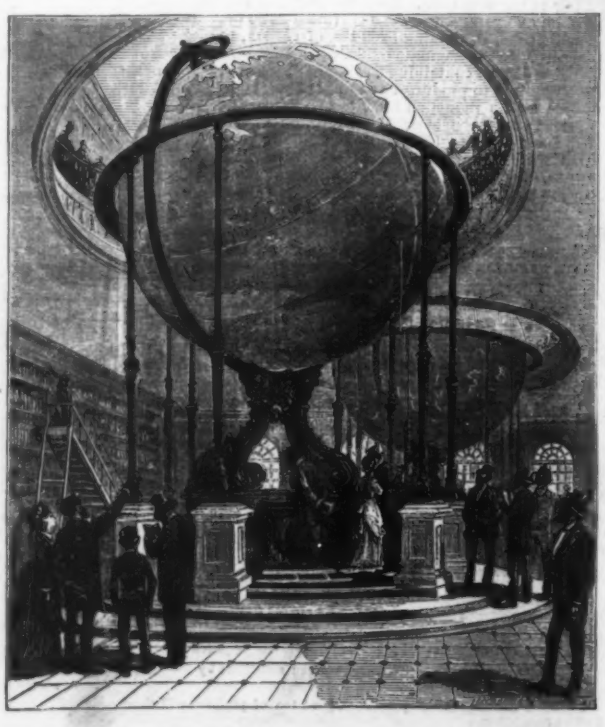
The stars and principal circles are of gilt bronze and in relief.

On the terrestrial globe, the seas are painted in a dark blue color; the land is white. The meridians of both globes are divided into degrees; but the horizon of the celestial globe is divided into twelve parts for the signs of the zodiac, opposite which are situated the corresponding days of the month. The horizon of the terrestrial globe has, besides the degrees, thirty-two winds indicated which are constantly represented on the compass. At the North Pole of each sphere is a small circle fixed to the meridian, divided into twenty-four parts; it is a horary circle on which moves a needle fixed to the axis of the system.

The terrestrial globe shows the state of the knowledge of geography at the end of the seventeenth century. The islands of Oceanica are especially defective; California is represented as an island (Isle de Californie); Central Africa is represented with rivers and lakes of the highest fancy.—*Charles Latort* (*La Nature*).

SCREW TRIALS.

THE Vesuvius, torpedo-vessel, Captain Singer, was again placed upon the measured mile in Stokes Bay, December 7th. As has been before stated, the object of these trials is to ascertain the relative merits of the Griffith three-bladed propeller, with which she was originally fitted, and the Thorneycroft three-bladed propeller, under like conditions, in steaming ahead and astern, which, in a special vessel like the Vesuvius, is of almost equal importance. The Griffith fans were tried about a fortnight ago, when a mean speed of 9.347 knots ahead and 7.778 knots astern was obtained, the mean number of revolutions per minute being 134 starboard and 136 port. On Tuesday the Thorneycroft propeller was subjected to trial. Wherever the Thorneycroft propeller has been adopted, whether in respect of boats or torpedoes, the result has been a considerable accession of speed. It is regarded as an axiom in mechanics that, other things being equal, oblique action is always a cause of inefficiency in a propeller, and hence the merit of the principle on which the Thorneycroft screw is founded, since it checks the radial flow of the water from the centre of the propeller, and throws it directly backward in a line with the keel. There is thus little or no waste of power. The propellers are made of Bessemer steel, forged, the blades being keyed into the bosses and further secured by end plates bolted to the bosses. The weight of the Griffith and the Thorneycroft propellers is about the same; but while the diameter of the former is 6 feet 6¾ inches and the mean pitch 8 feet 11-16 of an inch, the diameter of the latter is 6 feet 7 inches and the pitch 7 feet 8¾ inches. The state of the weather was nominally the same as on the previous trial, but while the wind was easterly and its force 2 on both occasions, there was considerably more lapper in the water yesterday, and therefore somewhat unfavorable to the new propellers, more especially in the runs astern, during which the waves rose over the rudder-head and swept the ship. In the following statement of results we place, for purposes of comparison, the data obtained at the trial of the Griffith screws within parentheses. The pressure of steam in the boiler on Tuesday was 60.5; vacuum in condensers, 23.66 lbs. (18.12 lbs.); highest mean of revolutions per minute, 150.98 starboard (144), and 156.5 port (143); mean per mile, 149 starboard (134) and 153.09 port (136); mean per mile, 909.5 starboard (887) and 934.33 port (900). The mean pressure in cylinders was 22.2 ahead and 16.618 astern, and the indicated horse-power 384 ahead and 278 astern. The mean speed of the six runs ahead against and with the tide, the wind and the tide being in the same direction, was 9.833 knots, as compared with 9.347 secured by the Griffith propeller. The gain is thus about half a knot an hour, but with increased horse-power and revolutions. The difference in the conditions, including also a difference in expansion, will probably make another trial necessary.—*Iron.*



THE GREAT GLOBES OF THE FRENCH NATIONAL LIBRARY.

NICKELIZING LIGHTNING-CONDUCTORS.

CONDUCTORS are usually made of an iron rod terminated by a point in platinum or gilt copper. Made in iron the point would oxidize rapidly and soon disappear. But in using two metals there is the disadvantage that contact between them is frequently defective, and if it were possible, the lightning-rod should be made of one homogeneous metal, without welding or solution of continuity. This is realized by M. Saint-Edme, who makes his conductor of a single rod of iron, in one piece from end to end, coated partly or entirely with nickel. The latter metal does not oxidize in damp air, it is a good conductor, and adheres closely to iron. The process of nickelizing is one easily and cheaply effected.